HEALTH SYMPTOMS FROM ALL WIRELESS DEVICES

INCLUDING MILITARY WEAPONIZATION OF THE ATMPSOPHERE (COMPONENT OF CHEMTRAILS)

- Confusion
- Short term memory loss
- Inability to focus
- Brain fog/sluggish thinking
- Difficulty concentrating
- Headaches
- Migraines
- Vision disruption or eye problems
- Eye pain
- Cataracts
- Head or chest pressure
- Allergies
- Difficulty breathing
- Respiratory problems
- Slow reaction time
- Sleep disruption
- Insomnia
- Night sweats
- Nightmares
- Dizziness
- Disorientation
- Balance Problems
- Agitation
- Anxiety
- Depression
- Suicide
- Tension
- Irritability
- Tremors
- Nervousness
- Seizures
- Vertigo
- Nausea or vomiting
- Flu-like symptoms
- Digestive difficulty
- Nose bleeds
- Hair Loss
- Rapid Aging/oxidative damage
- Skin problems including rashes
- Skin irritation/dryness
- White Noise 24/7
- Ringing or buzzing in ears
- Ear pain
- Tinnitus
- Bed wetting
- Urinary problems
- Behavioral problems in children
- Pets get jumpy
- Mood disorders
- Lethargy
- Exhaustion
- Chronic fatigue
- Lost productivity/sick days
- Loss of employment
- Unusual family conflicts
- Disintegrating relationships
- Disturbs Blood Brain Barrier Allowing Toxins to Enter

- Electronic Harassment-Stalking-Mind Control
- Controlling thoughts, Directing physical Actions. V2K Voice to Skull
  - Violent behavior
  - Autism
  - ADHD
  - Weakened immune system
  - Physical weakness or pain
  - High blood pressure
  - Leg cramps
  - Stiff neck or back
  - Shuts down the cells-cell death
  - Changes in genetic makeup
  - DNA breakage
  - EMF causes mercury dental filling vapor to leak causing organ and brain damage
- Psoriasis
- Autoimmune disease
- Lupus
- Damages mitochondria
- Free radical damage and aging
- Worsening existing poor health
- Demineralization of cells/tissue
- Impotence
- Infertility
- Birth defects
- Life span decreases by +/-8 years
- Heart Attack
- Pacemaker defibrillation
- Circulation problems
- Joint difficulty
- Muscle pain
- Fibromyalgia
- Dementia
- Personality changes
- Alzheimer's, Parkinson's. ALS Amyotrophic Lateral Sclerosis
- Childhood cancers increase
- Brain tumors
- Rare Deadly Brain Gliomas
- Leukemia
- Cancer
- Diabetes
- Heating beamed on humans that mimics a high fever
- Rhinitis (inflammation nasal membranes)
- Asthma
- Allergies such as hay fever
- Food allergy
- Atopic dermatitis (inflammation of the skin)
- Itching and chapped skin on the trunk
- Rheumatism (painful condition of the joints and muscles characterized pain and stiffness)
- Benign uterine fibroid tumors
- Bone loss/osteoporosis
- Dehydration
- Kidney damage

References:
*Bio Initiative Report: Over 2,000 Scientific Studies ***www.BioInitiative.org***
*AAEM-American Academy of Environmental Medicine - Position Paper "Electromagnetic and Radio Frequency Fields Effect on Human Health", including Wireless Technologies and Smart Meters
*Department of the Army - Fort Mead "Bioeffects of Selected Nonlethal Weapons" Radiofrequency directed energy and Microwave (EMF/RF Radiation) on Targets
* NASA: the Future of Warfare Document - Page 50 - Effects of Low Power Microwaves

www.StopTheCrime.net

Electrical Sensitivity

Electrical Sensitivity (ES) is also known as Electrosensitivity, Electromagnetic Sensitivity (EMS), EMF Sensitivity, Electrical Hypersensitivity (EHS), Microwave Sickness, Radio wave sickness, Wireless Stress Syndrome and Rapid Aging Syndrome. A key determining factor in evaluating whether or not someone has ES is how they feel away from EMF and RF and whether or not their health symptoms improve with prudent avoidance.

Symptoms

The symptoms of ES vary widely with each person, depending on the strength, type and length of exposure as well as exposure to other toxins in the environment, individual constitution and basic health practices. Symptoms can be mild to severe and include: tinnitus, chronic fatigue, headaches, insomnia, concentration, memory, learning and immune system problems, dermatitis, heart palpitations. nausea, joint pain, swelling of face, neck, eye problems, rashes, and cancer.

Suggestions for Healing

Practice Prudent avoidance of electricity, electromagnetic fields and radio frequencies

Reduce or eliminate cell, cordless phone and wi-fi use (unplug and remove)

Use a corded phone and wired internet connections (confirm the DSL router is wired)

If necessary move away from high EMF or RF environment (power lines, cell towers)

Sleep in an electricity free bedroom

Sleep in a metal free bed. Consider a wool bed.

Reduce electrical exposures as much as possible (use breaker box to turn power off)

Remove dimmer switches, CFL's, fluorescent lights

Install Stetzer filters to mitigate "dirty electricity"

Use a notebook computer on battery with an external (wired) keyboard and wired mouse

Never use the computer on your lap

Work offline when possible

Have your home, car and work tested for EMF and RF (click here for a detailed review of meters to buy or rent)

Alternative health care can be very beneficial: Chiropractic, acupuncture, herbs, massage.

Eat fresh local organic foods.

Follow all rules for basic good health and take it slow: Healing comes with time and distance

Work with policy makers to create responsible public policy to reduce EMF and RF in the environment.

Mast-Victims.Org an online community where people "living under the threat of masts and antennas can record their case histories and share their thoughts online."

Radiation Research Trust EHS TEST

Electrical Sensitivity E-SENS online discussion group

Susan Parsons: "Living with Electrohypersensitivity-A Survival Guide"

Lucinda Grant: Electrical Sensitivity Handbook

Sarah Dacre electro-sensitivity story

Katie Hickox EHS story

EMF Electrician Michael Neuert: "Electromagnetic Fields and Your Immune System"

Dr. Christine Aschermann:"Observations from a Psychotherapy Practice on Mobile Telecommunications and DECT Telephones"Aschermann2009

Forced to Disconnect – Electrohypersensitive fugitives e book by Gunilla Ladberg

Go to the EMF Tab of SmartMetersMurder.com for the various links on this page

Watch - The Cooking of Humanity

Vacuum Pump

VACUUM PUMP AND VACUUM CHAMBER

Kimberly Hoffman, *Biomedical Engineering, University of Rhode Island*
BME 281 Second Presentation, November 12, 2013 <khoffman11@my.uri.edu>

***Abstract*—Researchers are working on making electronic skin more sensitive to mimic human skin. They are also working on making it flexible to use around joints without damaging the electronics. They are creating different uses for electronic skin as well.**

I. Introduction

ELECTRONIC skin is a thin material that contains electrical components that acts like real skin in one or more ways. Some of the things skin can do are sense temperature and pressure, stretch, and repair itself. The goal for electronic skin is to be able to do all of these.

The University of Tokyo made a type of electronic skin that wrapped around a robotic hand. They thought that if a human shook hands with the robot wearing the electronic skin, the pressure and temperature senses could pick up their vital signs. Then they started working on making electronic skin for humans. Electronic skin could monitor medical conditions, or be used on prosthetics to make them more sensitive. Their biggest problem was getting the electronic skin to stretch over joints like elbows and knees without damaging the electronics within it. Their goal is to create large amounts of electronic skin economically and make it so it can mimic real skin. They have not been able to do all of this yet.

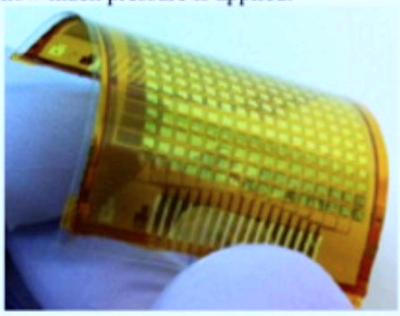
II. Methods

One of the first steps in making electronic skin is making the components flexible. They need to be able to bend, similar to how wires can bend. One component that is used in making electronic skin is thin film transistors (TFTs). These TFTs can be made of different materials like silicon, organic semiconductors or carbon nanotubes. They are made by putting thin layers down at a time. The piece these TFTs are printed onto can be made of ultrathin glass, stainless steel foils, and plastic films.

Scientists experimented on these different materials, and determined that plastic films could be a practical option. Plastic films are tough and they do not change shape under stress. They are inexpensive, and can be used with new manufacturing processes that can make large sheets of electronics. If they were going to print TFTs on plastic film, they need to keep the temperature low to prevent the plastic from changing shape. Using organic semiconductors for the TFTs would be best, because they can be printed at room temperature.

III. Results

Researchers at the University of California, Berkeley, have developed an electronic skin that responds to pressure by producing light from an LED. It is 16 by 16 pixels, and each pixel has a carbon-nanotube thin-film transistor, a pressure sensor, and an organic light emitting diode (OLED). When it senses pressure, the TFT lights up the OLED, and it will produce a blue, red or green light. The intensity of the light depends on how much pressure is applied.



They made organic transistors and sensors on an ultrathin polymer sheet that is 1 micrometer thick. This material can bend, crumple, and stretch up to 230 percent. It will still work at a high temperature and in aqueous environments, including saline solutions, so it could be used inside the human body.

Researchers have also created a type of electronic skin that could stick to skin like temporary tattoos. The circuit gets transferred onto a water soluble plastic sheet, and then gets put onto the patient and it can be used to help doctors monitor vital signs without wires and contact pads. They were able to successfully use this design on the throat, and the sensors pick up the muscle activity used when speaking, and the researchers were able to identify some words the person said.

IV. Discussion

In the future, there are many ideas for potential uses for electronic skin. One of the ideas is wearing the electric skin on the wrist with the sensors facing the skin to monitor pulse and blood pressure. The sensors could be facing away from the skin and be sensitive enough to sense a fly on the sensors or a light breeze. Electronic skin could also be light sensitive or have ultrasonic detectors in it. One idea researchers had was covering a robot in this ultrasonic skin that could analyze its surroundings, and it would be able to measure the distance between the robot and obstacles around it, so it will not crash into anything. If they used this on prosthetics, they could be hyperaware of things around them. They also had an idea of being able to charge a prosthetic by resting it on a charger.

References

[1] "Bionic Skin for a Cyborg You." - *IEEE Spectrum*. Web. <http://spectrum.ieee.org/biomedical/bionics/bionic-skin-for-a-cyborg-you>.

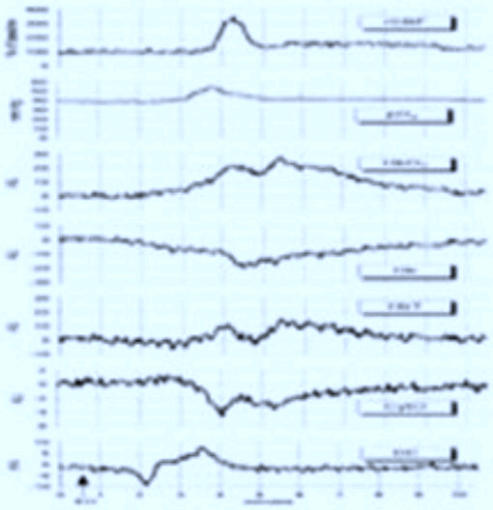
[2] "Electronic Skin Lights Up When Touched." - *IEEE Spectrum*. Web. <http://spectrum.ieee.org/biomedical/devices/electronic-skin-lights-up-when-touched>.

[3] "Electronic Skin." *Wikipedia*. Wikimedia Foundation, 11 Sept. 2013. Web. <http://en.wikipedia.org/wiki/Electronic_skin>.

ww.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwj3j5TJjYfhAhVROKwKHd-6ASwQjRx6BAgBEAU&url=https%3A%2

Brain Computer Interfaces – SCP BCIs

- detection of slow cortical potentials (SCPs)
- needs DC EEG Amplifiers
- first successful device end 1990‘s:
  Niels Birbaumers Thought translation device
  intensive training was necessary to gain
  control over the SCP waves

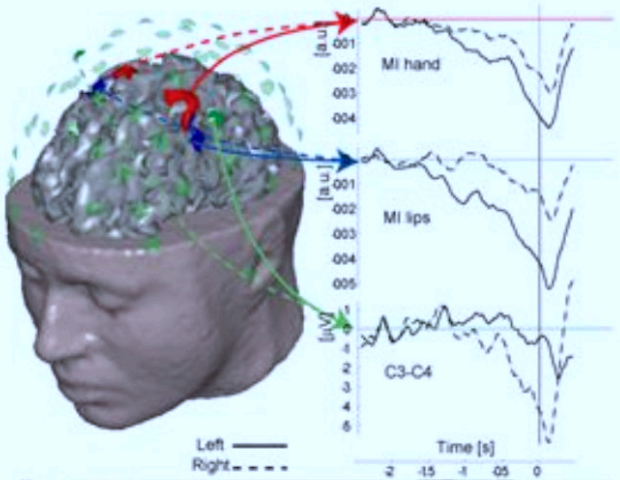


SCPs:

DC-shifts, slow negativation of cortical areas

Preparation of movement and cognitive tasks,

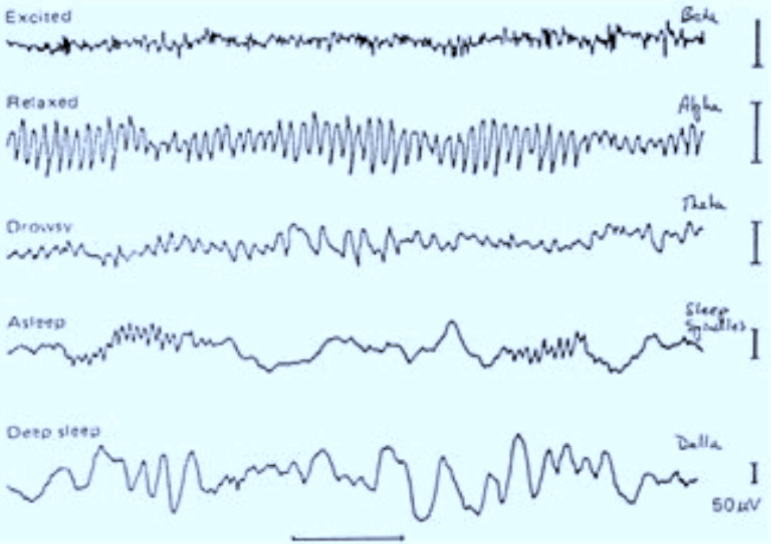
Several hundert milliseconds before the task



Patinet using TTD to write a letter
http://www.heise.de/ct/06/18/088/bild1.jpg

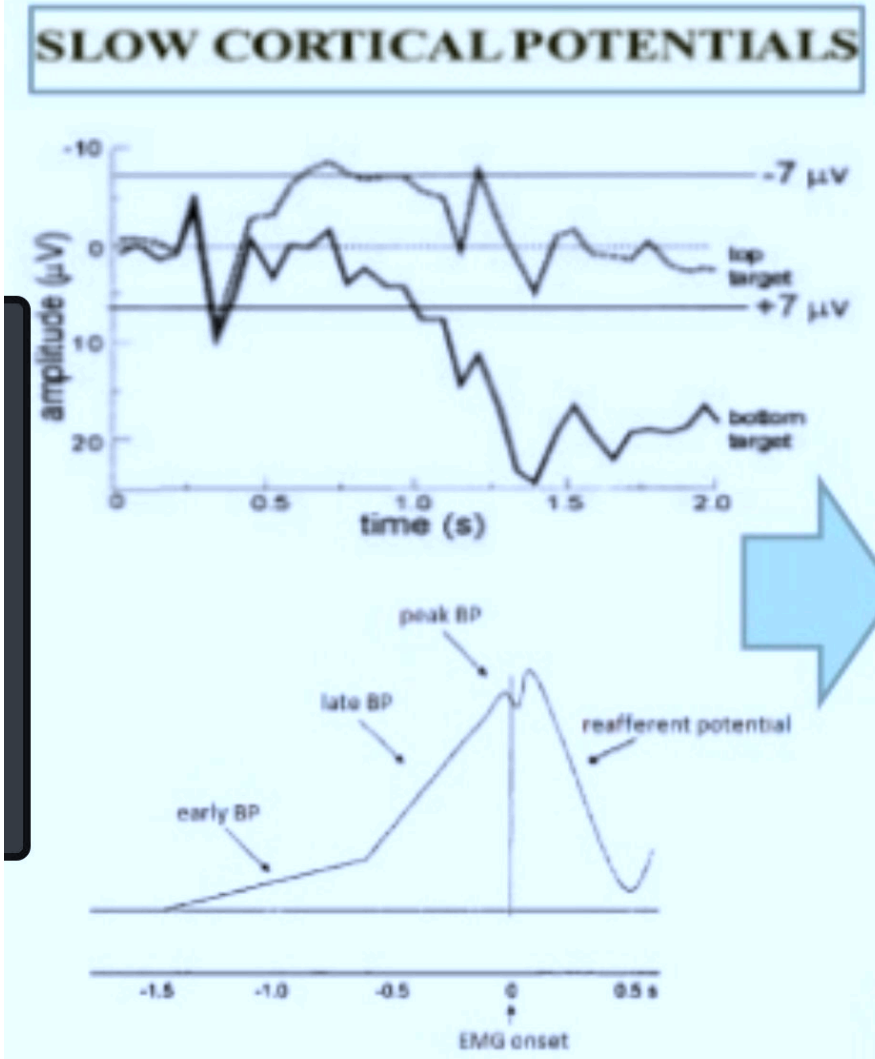
1. EEG-Based Systems

- BCI experience has been limited to EEG recordings
- Studies have investigated the use of **sensorimotor rhythms**, **slow cortical potentials** and **P300 evoked potentials**



MOTOR IMAGERY CORRELATES IN EEG

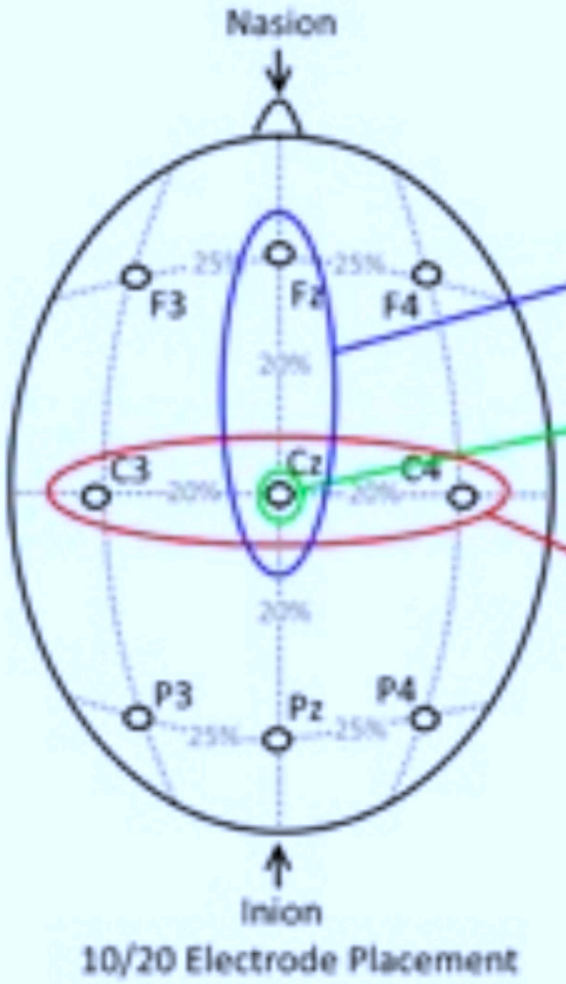
SLOW CORTICAL POTENTIALS [Kornhuber and Deecke (1965)]



- Know as BereitschaftPotential (readiness potential) or Movement Related Cortical Potentials (MRCPs).
- Slow oscillations preceding the movement
- Localized over the supplementary motor area (SMA)
- Steps for MRCP detection
  - Spatial filter,
  - LP frequency filter
  - Template extraction from the training data
  - matching with the ongoing eeg

- Frequency close to the DC -> very

'STANDARD' NEUROFEEDBACK PROTOCOLS



10/20 Electrode Placement

Theta/Beta neurofeedback

Slow Cortical Potential (SCP) neurofeedback

Sensori-Motor-Rhythm (SMR) neurofeedback

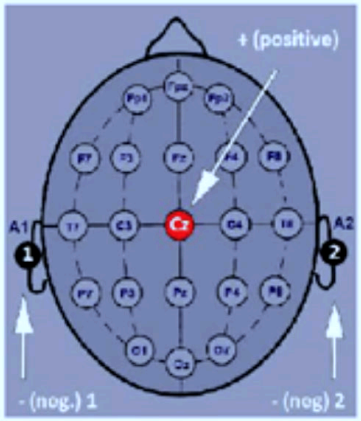
Connecting the hardware

1. Connect the SCP Sensor for SCP to input A&B of the NeXus. Connect the EXG Sensor for EOG to input CD of the NeXus. Connect the Ground Sensor to the left input, labeled Gnd.
2. Snap the appropriate electrodes into the red and black connectors of the SCP Sensor. See the following overview.

Red:	Positive (active) input:	Channel A & B
Black-1:	Negative (reference) input:	Channel A
Black-2:	Negative (reference) input:	Channel B

3. Snap the appropriate electrodes into the red and black connectors of the EXG Sensor. See the following overview:

Red-1 and Black-1:	Vertical EOG (VEOG; required):	Channel C
Red-2 and Black-2:	Horizontal (HEOG; optional):	Channel D



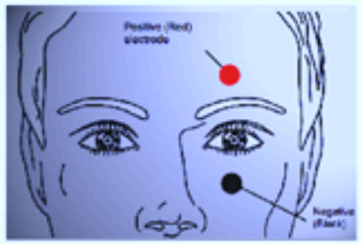
Electrode placement

SCP electrodes: The NeXus SCP cable is placed on the head using sintered electrodes, with the RED electrode on Cz, the Black electrode (marked with 1) on the LEFT earlobe or mastoid, and the Black electrode (marked with 2) on the RIGHT earlobe or mastoid. The ground electrode can be placed anywhere on the body, for instance on Fz/FPz.

VEOG electrodes: Place the red-1 (positive) electrode above the eye and the black-1 (negative) electrode below the eye.

Mounting the electrodes

SCP electrodes: When monitoring DC-EEG signals there will always be some level of DC-drift. If this stays within an acceptable range, it does not have to be a problem. In order to reduce DC-drift: we always advise to use sintered Ag/AgCl electrodes for DC-EEG and SCP applications and do good skin preparation.



1. Before attaching the electrodes, perform good skin preparation to peel off excess dead skin cells from the scalp. This will lower the skin resistance (or DC-offset). Use an abrasive gel, like NuPrep, for this. Rub it lightly over the skin (e.g. with a cue tip). Remove excessive gel with a clean gauze pad.
2. To adhere the electrode to the skin and to support the skin conductance, apply some electrode paste to the electrode, using chloride based conductive gels/paste like Ten20 or ECI-gel.
3. Press the electrode firmly onto the skin at the site of interest.

Other

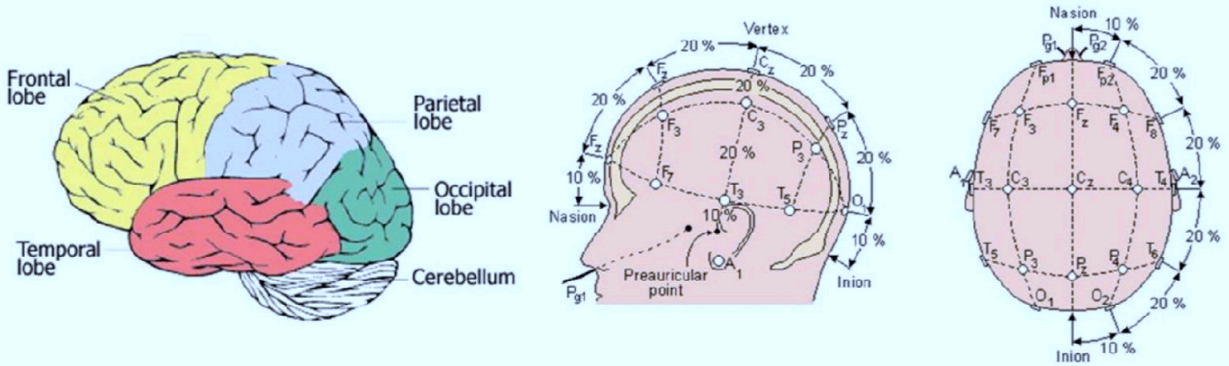


Figure 2. Identifying parts of the brain and location of electrodes in the International System 10-20 EEG Companies[14].

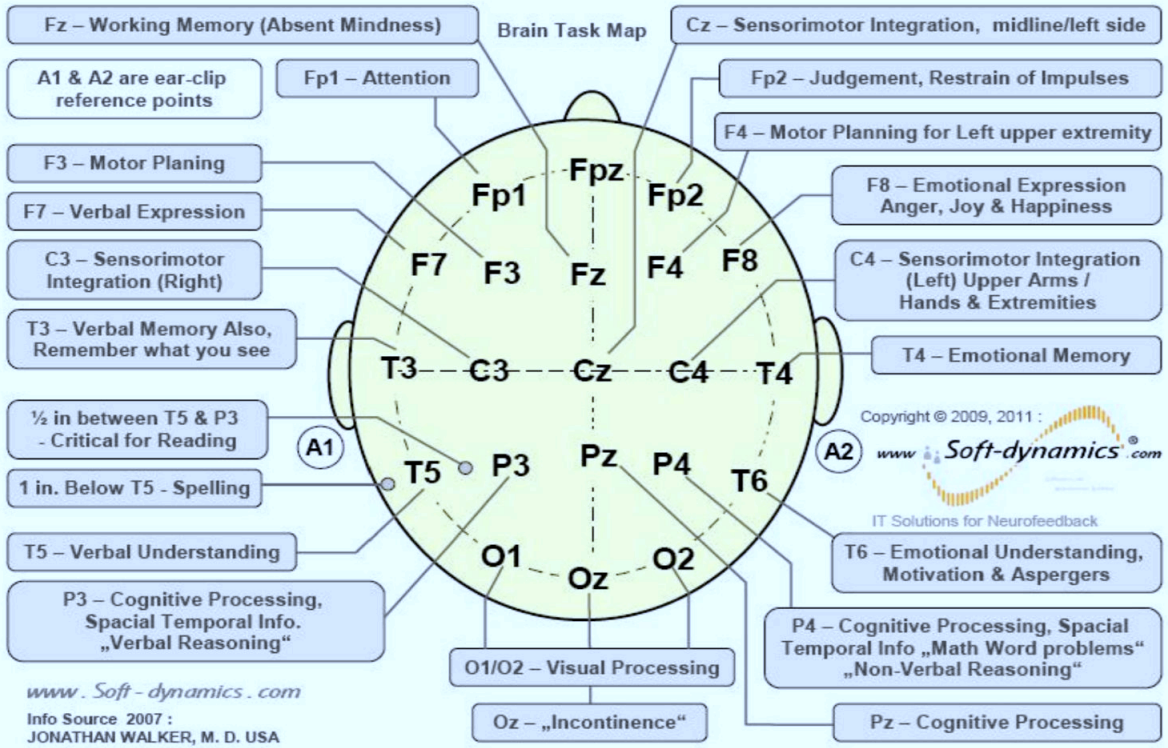
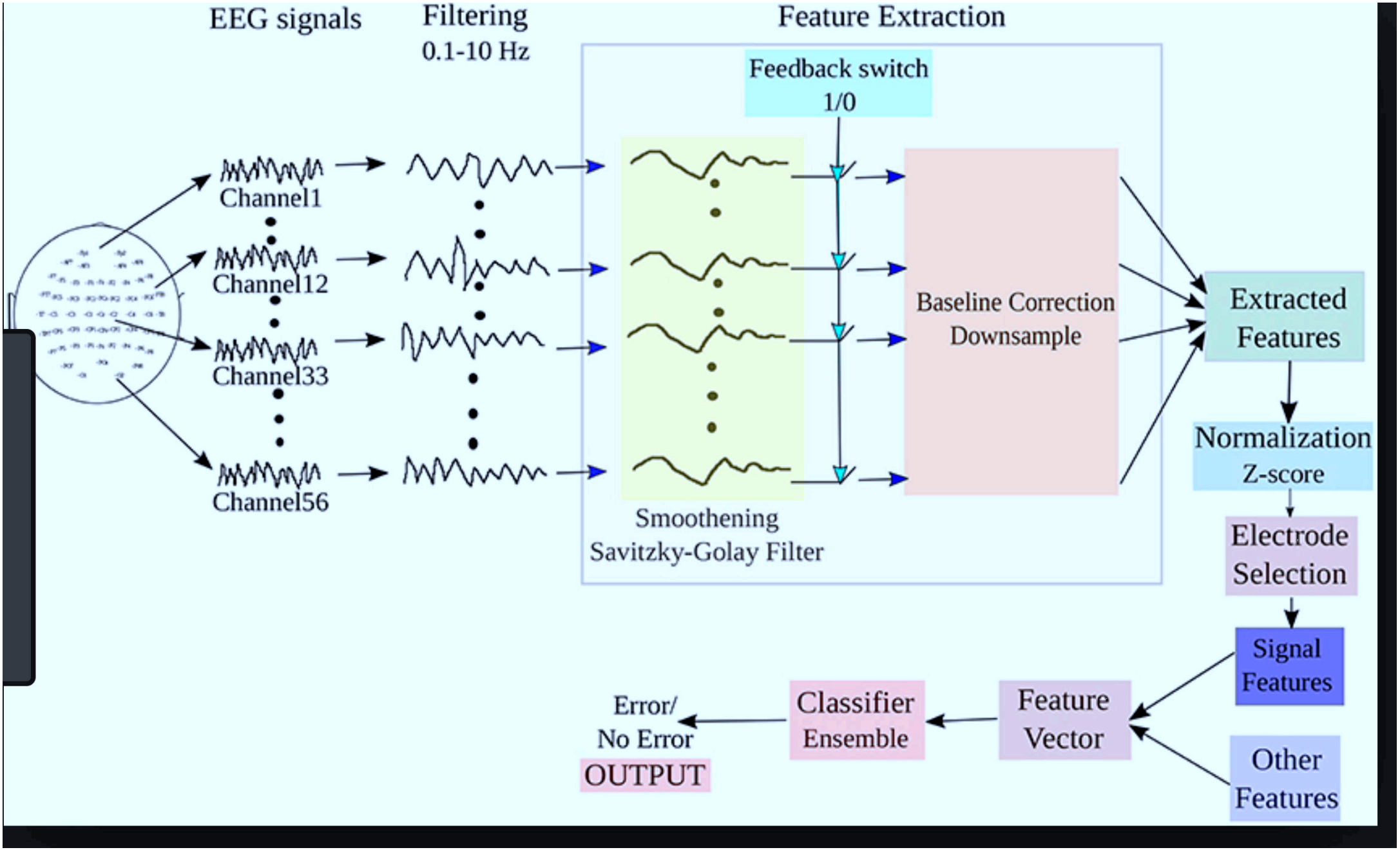
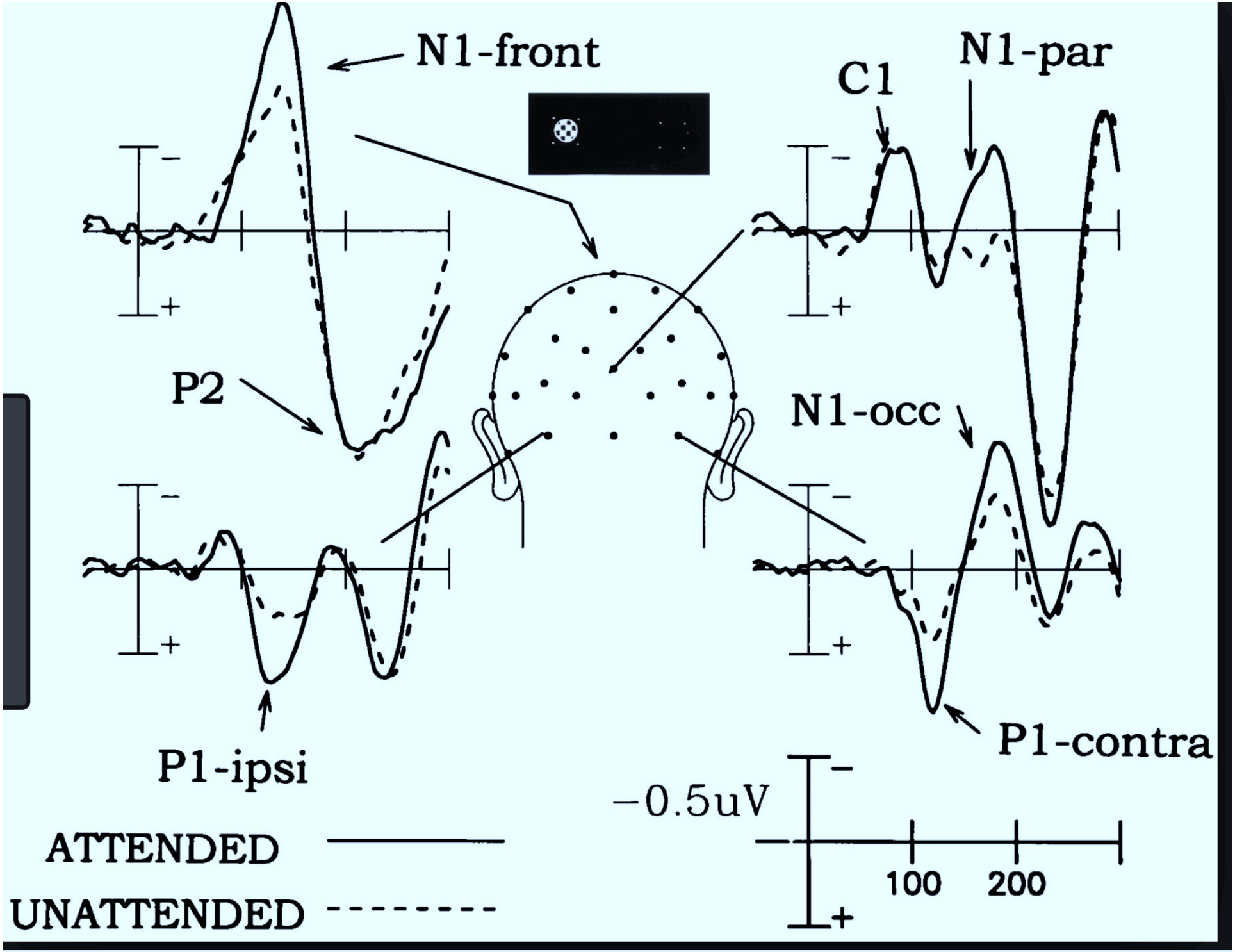


Figure 3. Identification of electrodes international 10-20 system and Map of brain activities with the location of the electrodes on the scalp[18].


EEG signals
Filtering
0.1-10 Hz
Feature Extraction
Feedback switch
1/0
Channel1
Channel12
Channel33
Channel56
Baseline Correction
Downsample
Extracted
Features
Normalization
Z-score
Electrode
Selection
Signal
Features
Other
Features
Feature
Vector
Classifier
Ensemble
Error/
No Error
OUTPUT
Smoothening
Savitzky-Golay Filter



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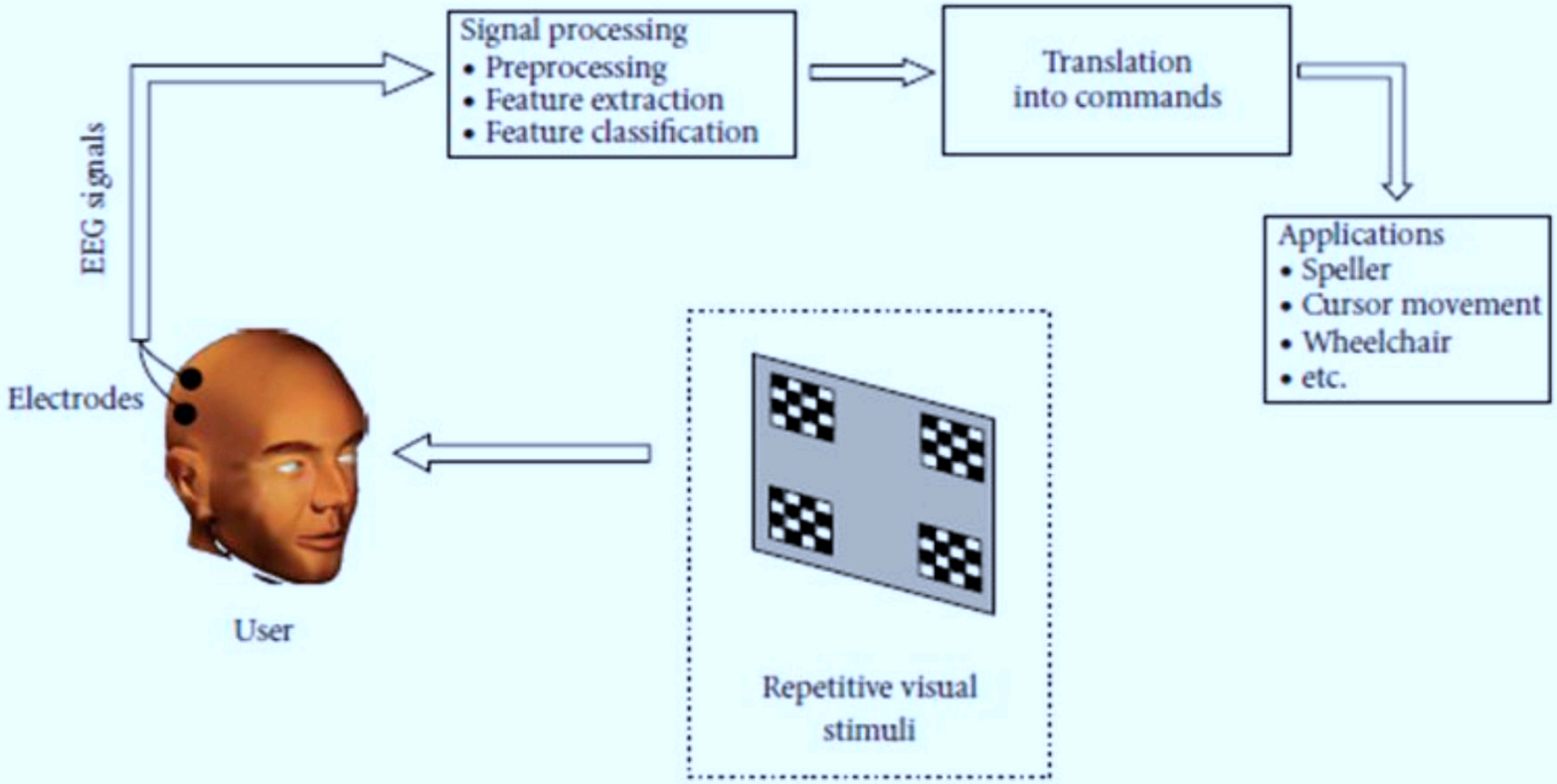
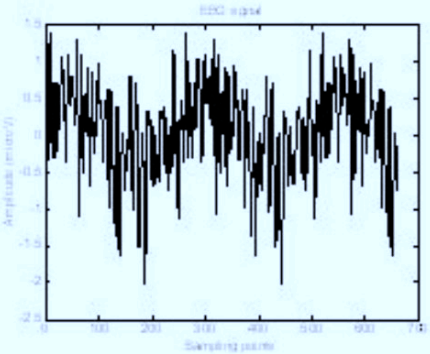
Steady-state Visual Evoked Potential (SSVEP)

SSVEP is an EEG signal response to the flickering visual stimulus with a frequency higher than 6 Hz [1]

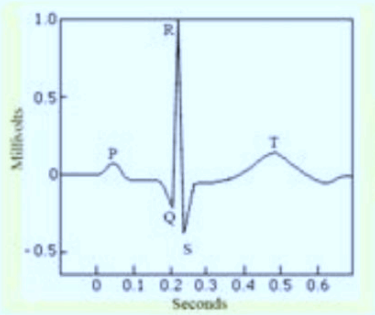


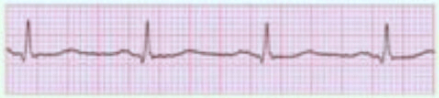
Examples of biological signals

- EEG
  - Oscillating electrical potentials recorded from the scalp surface.
  - Very small in amplitude (μV range).
  - Generated by neuronal activations in the brain.
  - Evoked potentials – a specific type of EEG evoked during a stimulus like visual, auditory, etc.



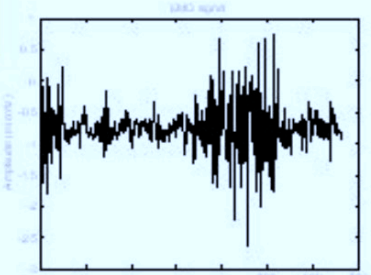
- ECG
  - Electrical potentials recorded from the chest (mainly), arms, legs.
  - Generated by electrical activity of the heart, which results in heart pumping blood



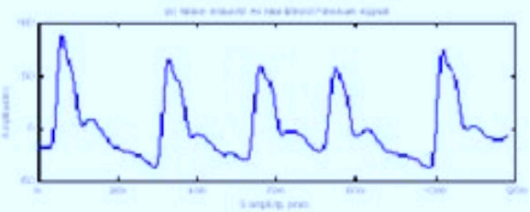


ECG pictures from S.K.Mitra, DSP 3e

- EMG
  - Electrical potentials recorded from the skin.
  - Generated by skeletal muscle activity.



- ABP
  - Pressure recorded on the upper arm (units-mmHg)
  - Generated by changes in blood pressure



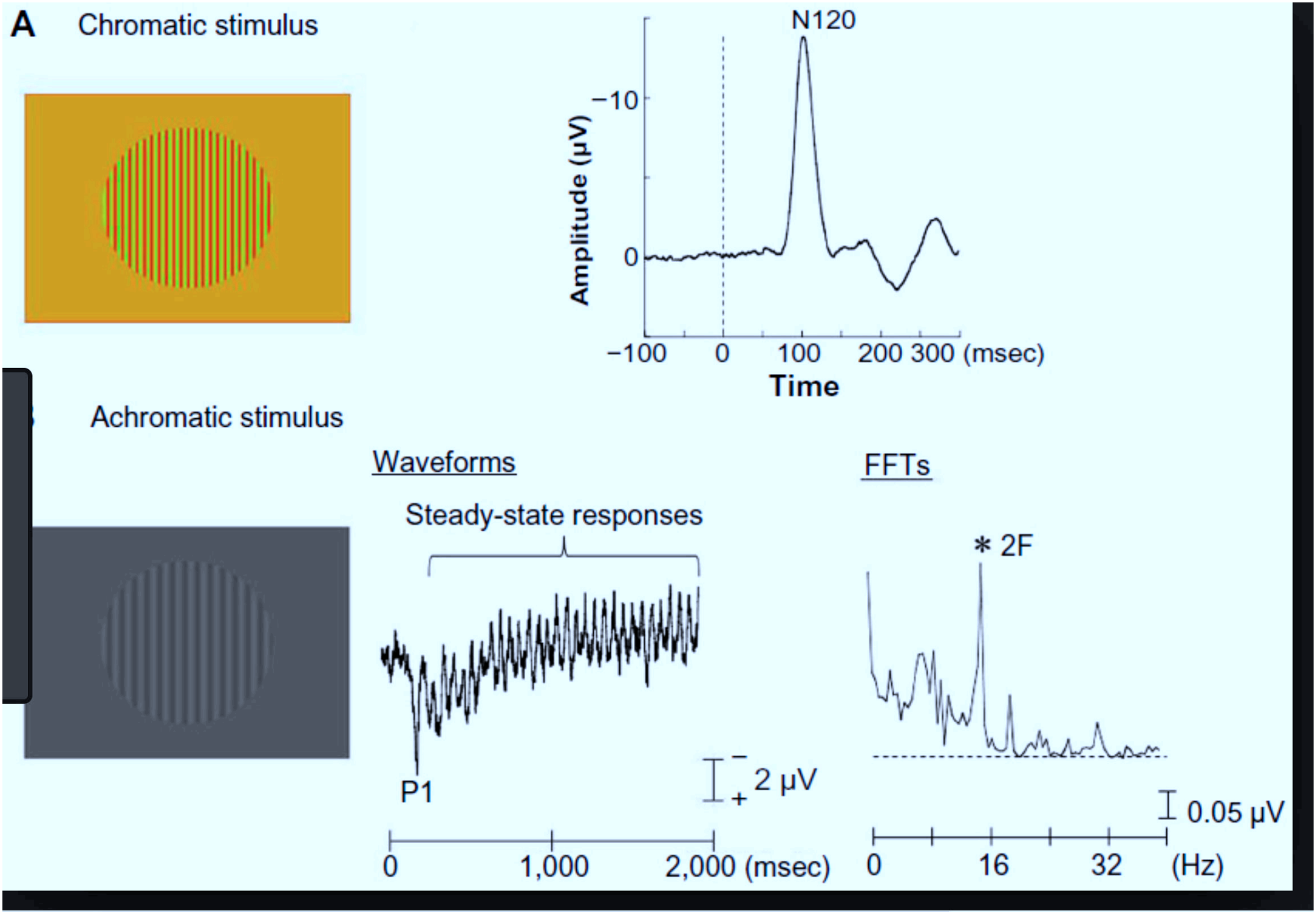
Visual Evoked Potential (VEP)

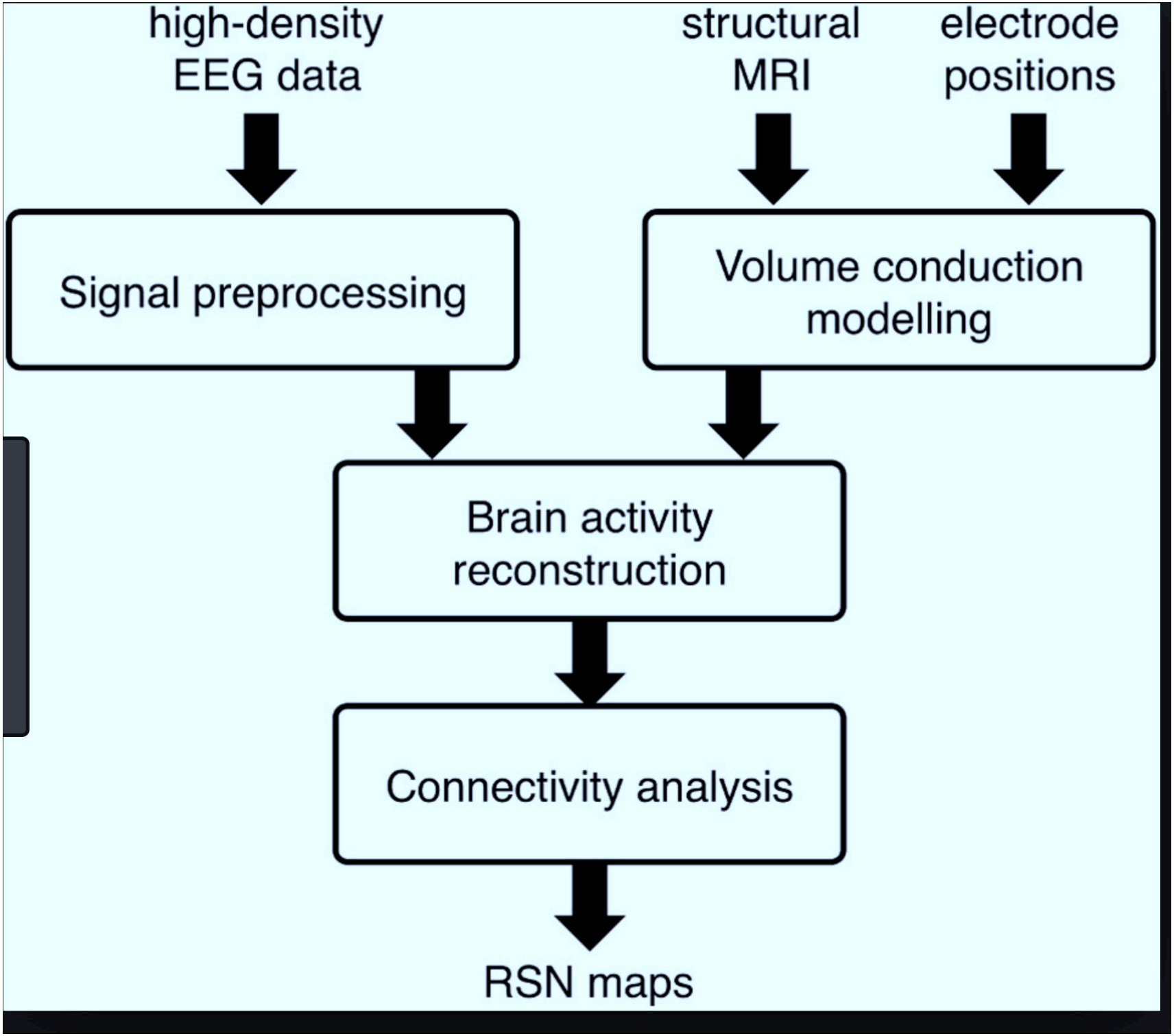
Visual acuity = the ability to see fine detail and patterns

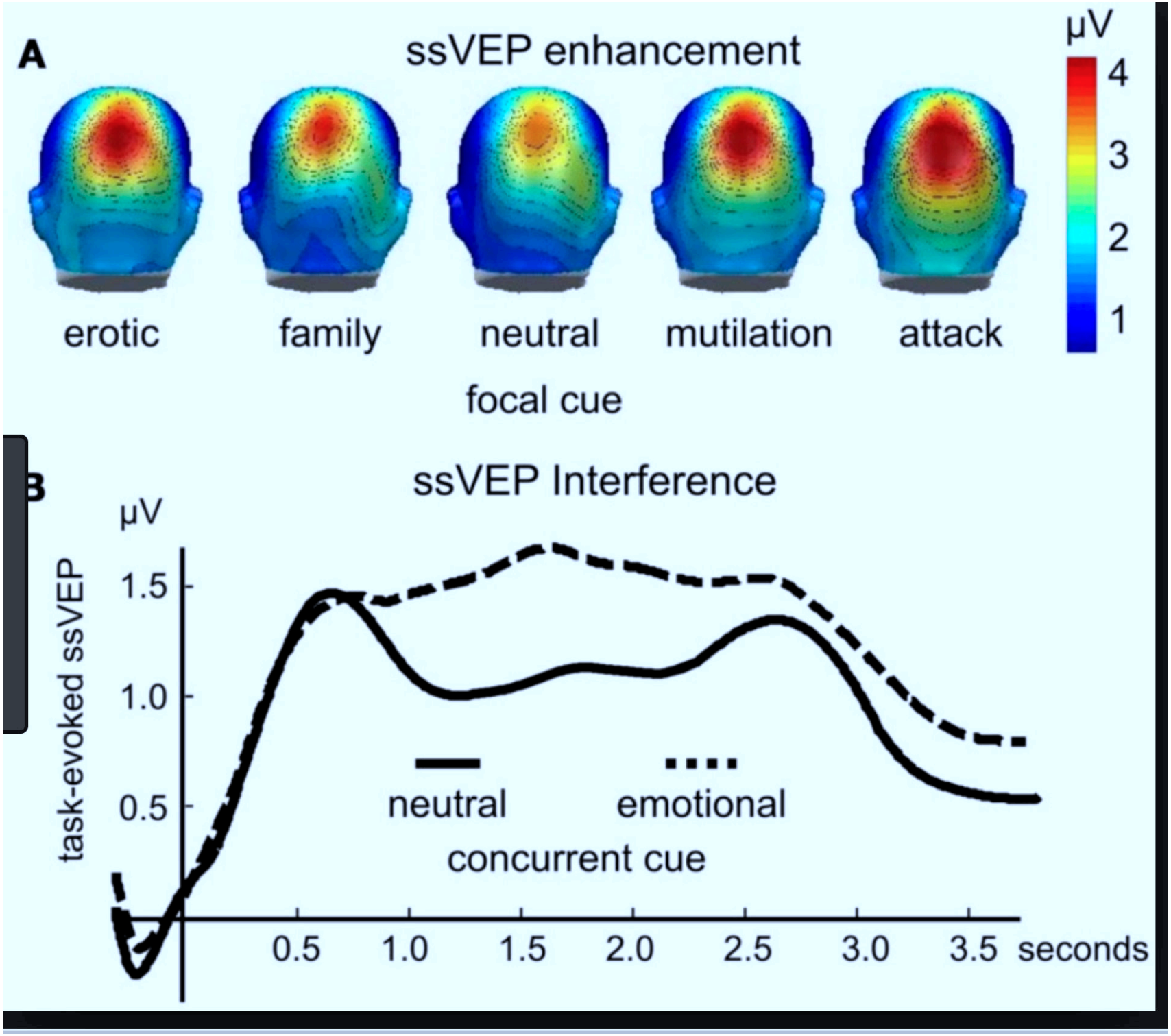
A 'visual evoked response' (VER) or 'visual potential test' is a record of the electrical activity in the brain as a response to stimulation of the retina.
These signals are recorded with electrodes lightly attached to the scalp at the back of the head while the child watches patterns on a computer screen.

measures the response of the brain to alternating black and white stripes or checks.

designed to find the finest black and white stripes that reliably produce a response


A
Chromatic stimulus
N120
−10
0
Amplitude (μV)
−100
0
100
200 300 (msec)
Time
Achromatic stimulus
Waveforms
FFTs
Steady-state responses
* 2F
P1
2 μV
0.05 μV
0
1,000
2,000 (msec)
0
16
32
(Hz)


high-density
EEG data
structural
MRI
electrode
positions
Signal preprocessing
Volume conduction
modelling
Brain activity
reconstruction
Connectivity analysis
RSN maps


A
ssVEP enhancement
μV
4
3
2
1
erotic
family
neutral
mutilation
attack
focal cue
B
ssVEP Interference
μV
task-evoked ssVEP
1.5
1.0
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neutral
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concurrent cue
0.5
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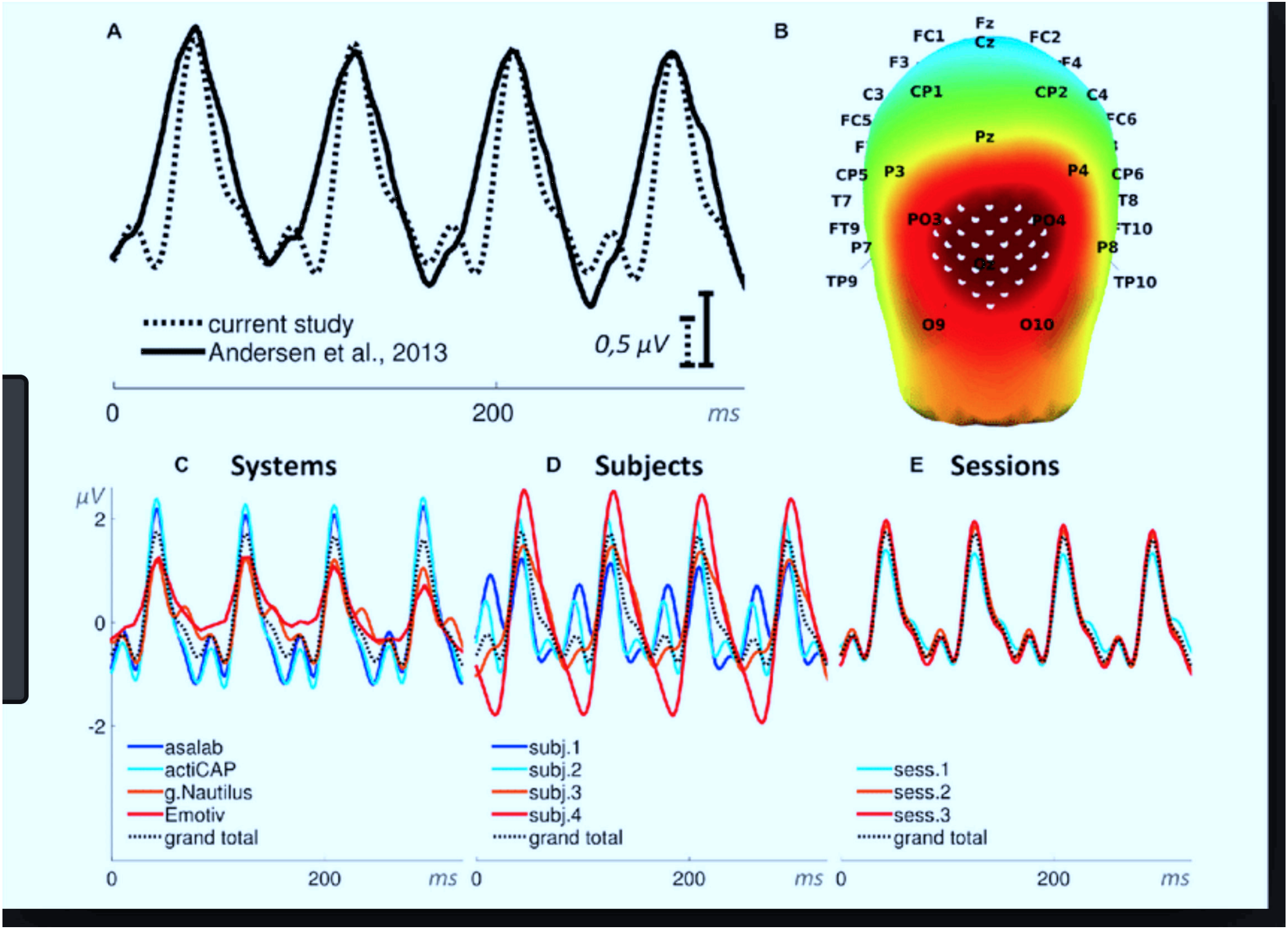
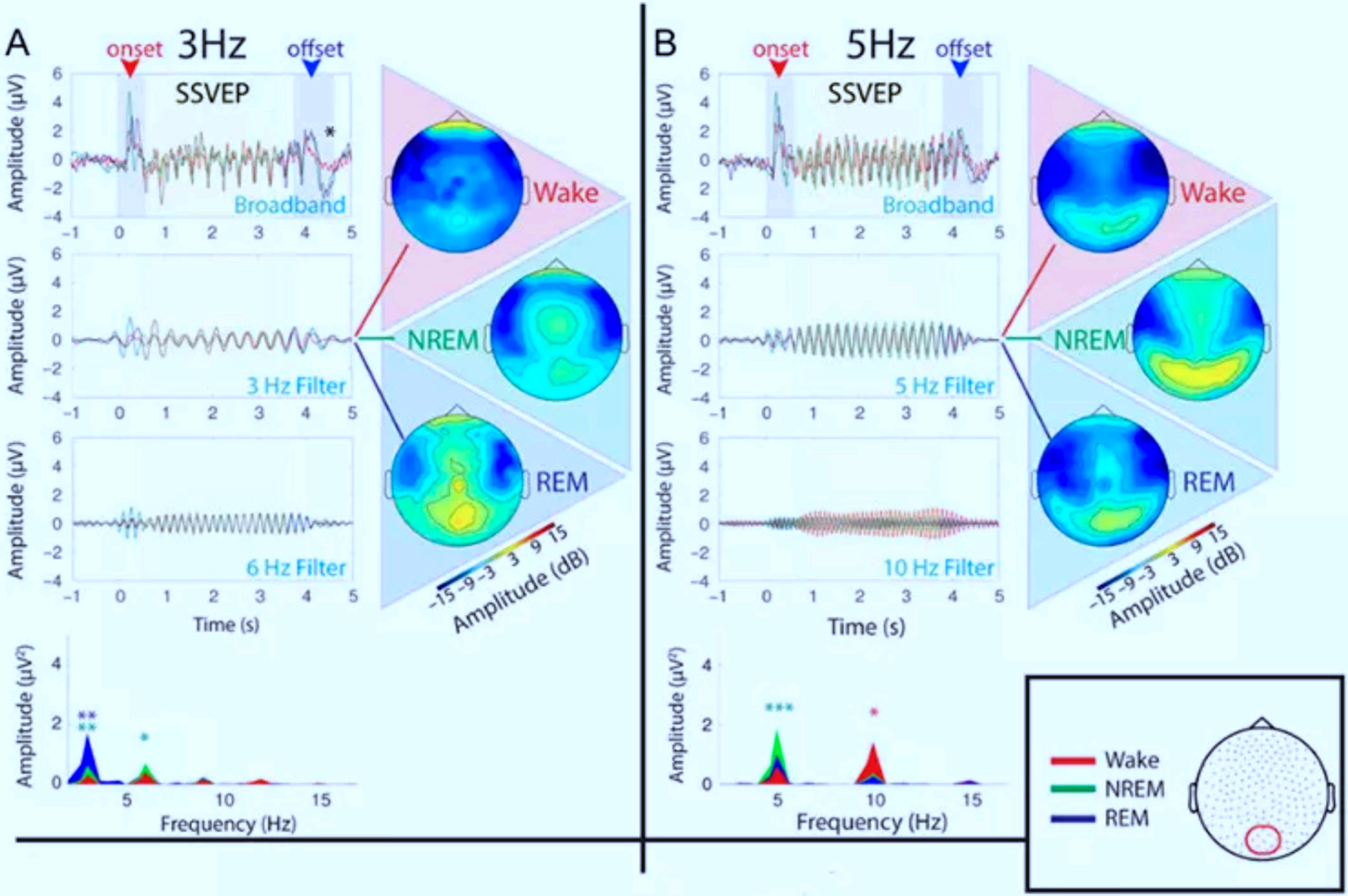
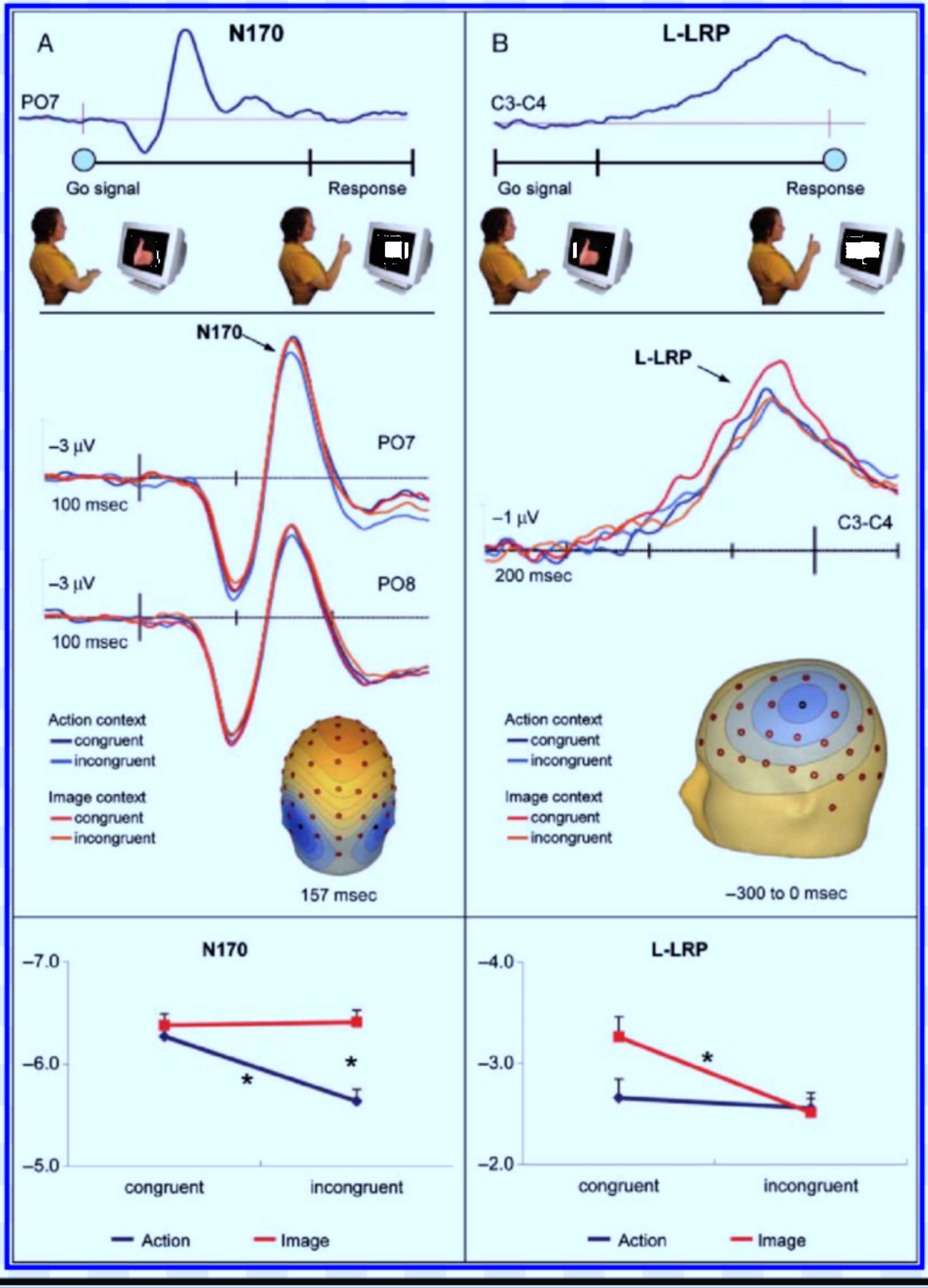
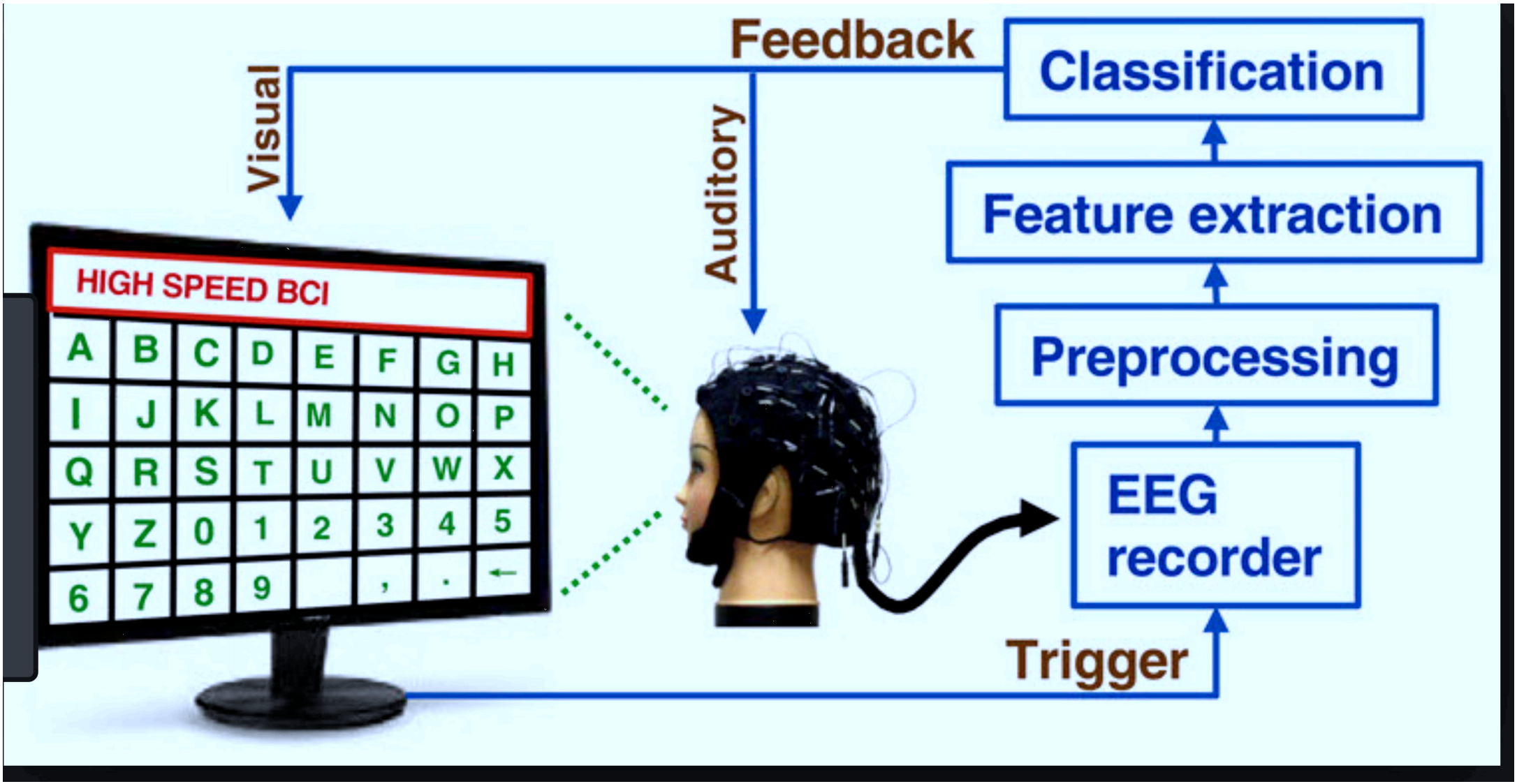
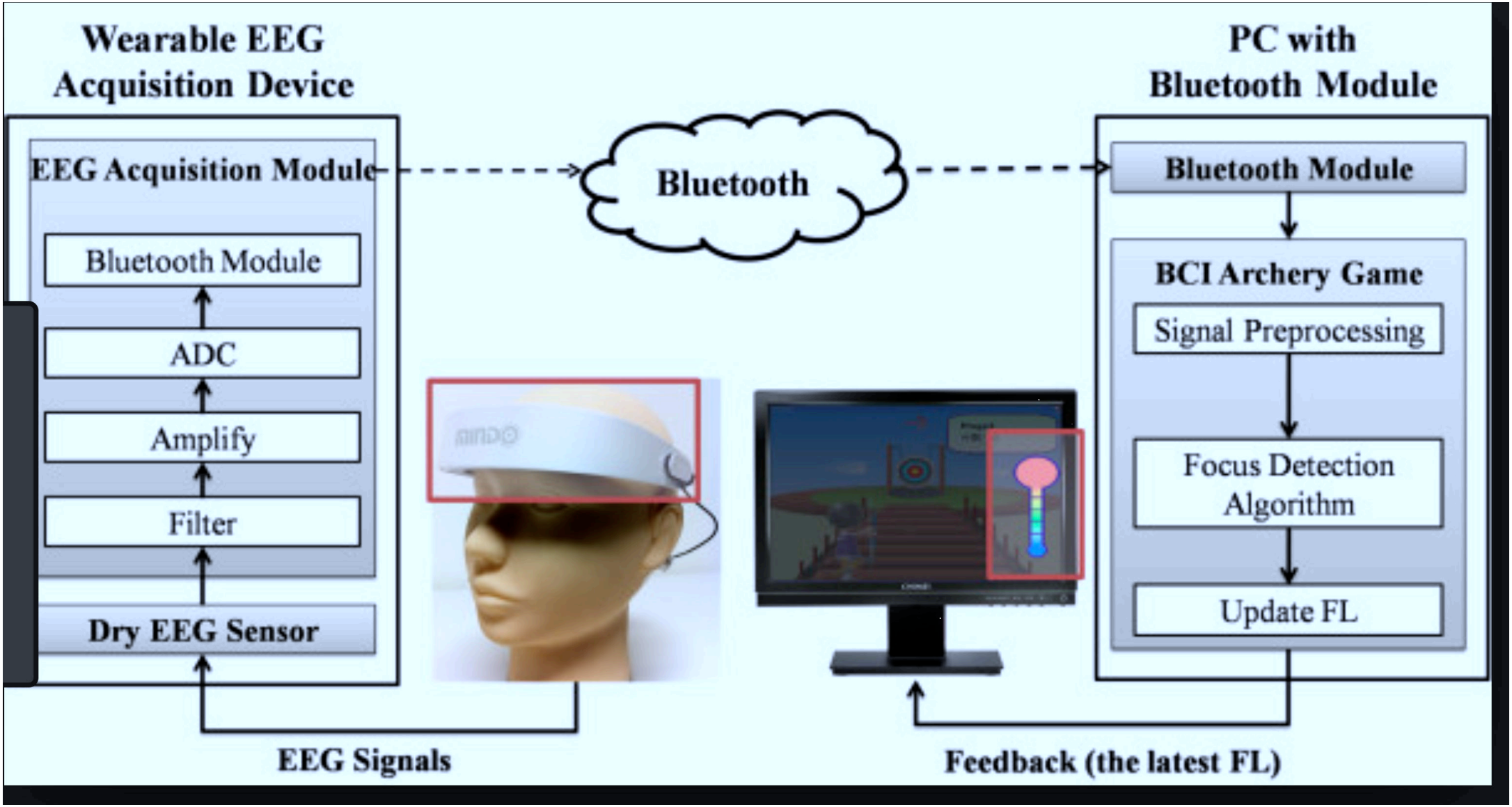
seconds

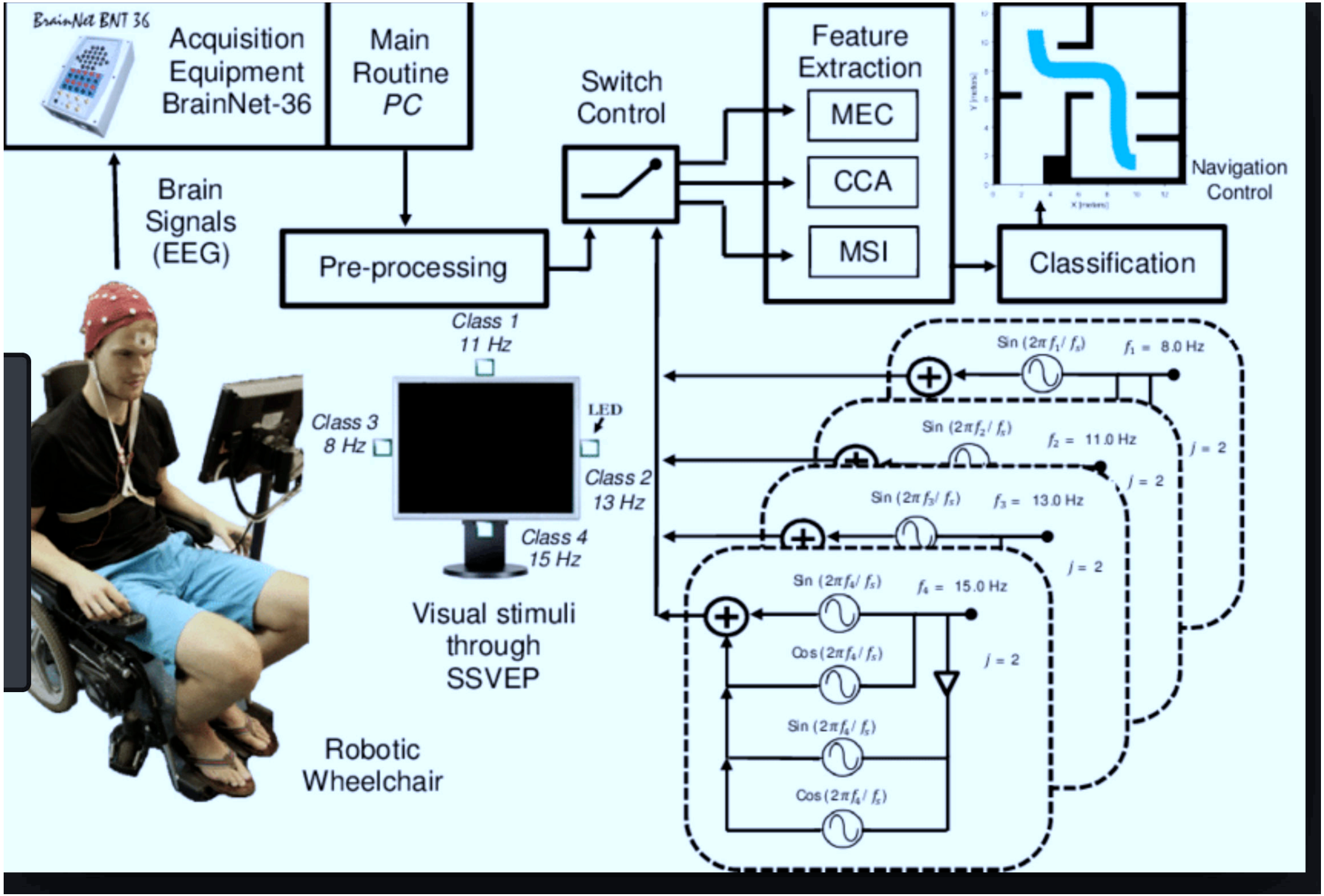

A
current study
Andersen et al., 2013
0,5 μV
0
200
ms
B
Fz
FC1
Cz
FC2
F3
F4
C3
CP1
CP2
C4
FC5
FC6
Pz
CP5
P3
P4
CP6
T7
T8
PO3
PO4
FT9
FT10
P7
P8
Oz
TP9
TP10
O9
O10
C Systems
D Subjects
E Sessions
μV
2
0
-2
asalab
actiCAP
g.Nautilus
Emotiv
grand total
subj.1
subj.2
subj.3
subj.4
grand total
sess.1
sess.2
sess.3
grand total
0
200
ms

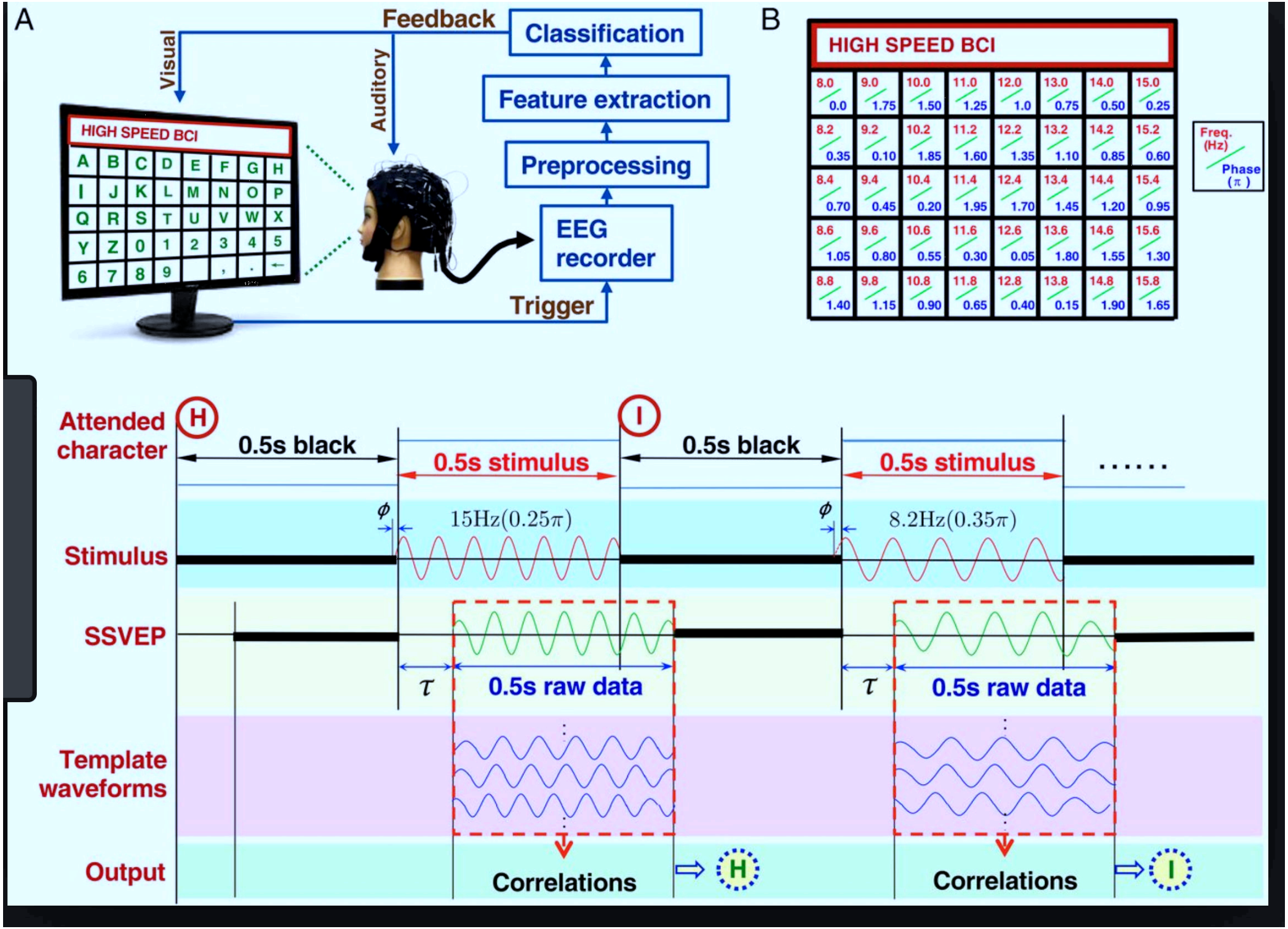

A
onset
3Hz
offset
SSVEP
Broadband
3 Hz Filter
6 Hz Filter
Amplitude (μV)
Time (s)
Wake
NREM
REM
Amplitude (dB)
Amplitude (μV²)
Frequency (Hz)
B
onset
5Hz
offset
SSVEP
Broadband
5 Hz Filter
10 Hz Filter
Wake
NREM
REM

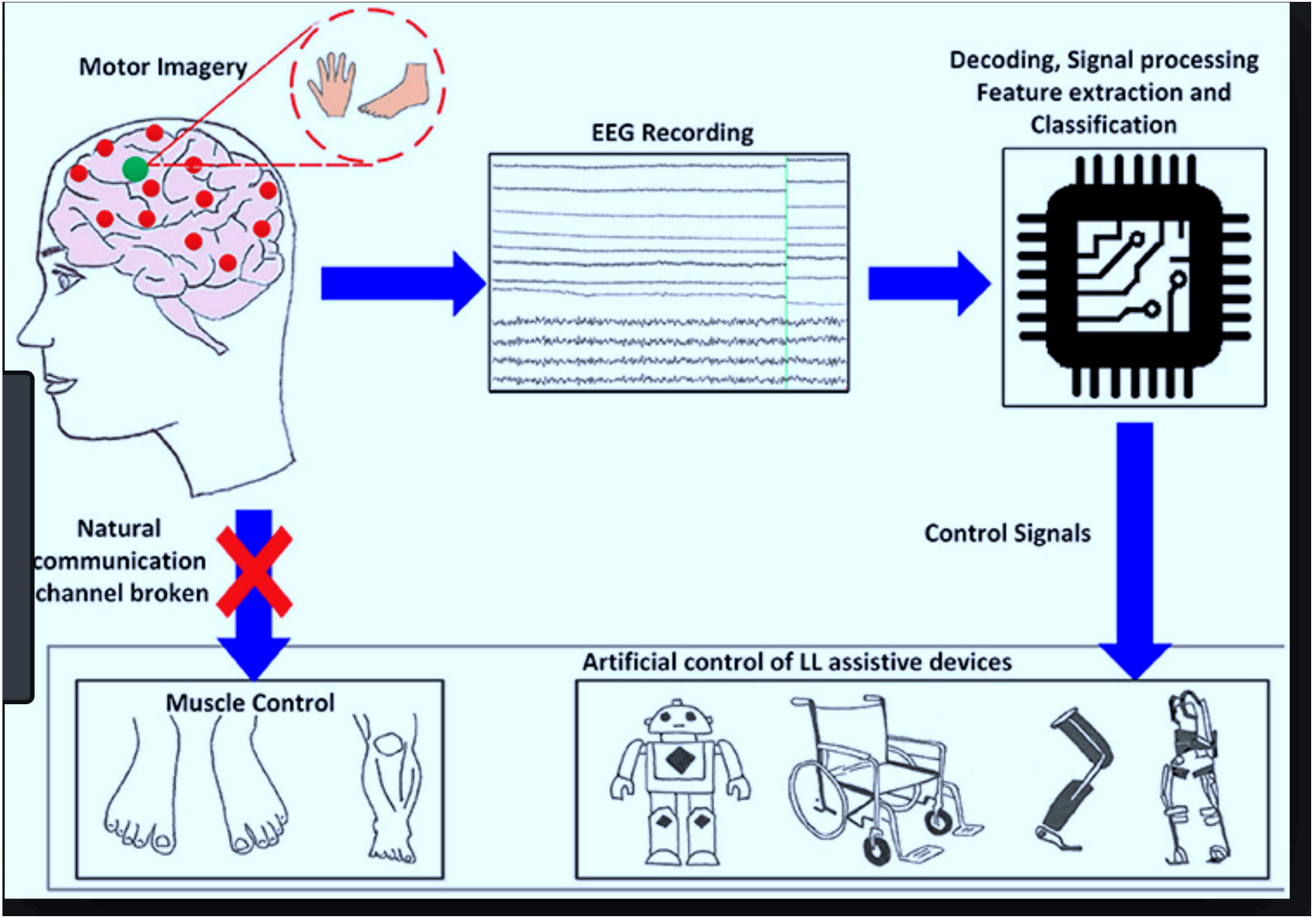

A
N170
PO7
Go signal
Response
N170
–3 μV
PO7
100 msec
–3 μV
PO8
100 msec
Action context
congruent
incongruent
Image context
congruent
incongruent
157 msec
B
L-LRP
C3-C4
Go signal
Response
L-LRP
–1 μV
C3-C4
200 msec
Action context
congruent
incongruent
Image context
congruent
incongruent
–300 to 0 msec
N170
–7.0
–6.0
–5.0
*
*
congruent
incongruent
Action
Image
L-LRP
–4.0
–3.0
–2.0
*
congruent
incongruent
Action
Image

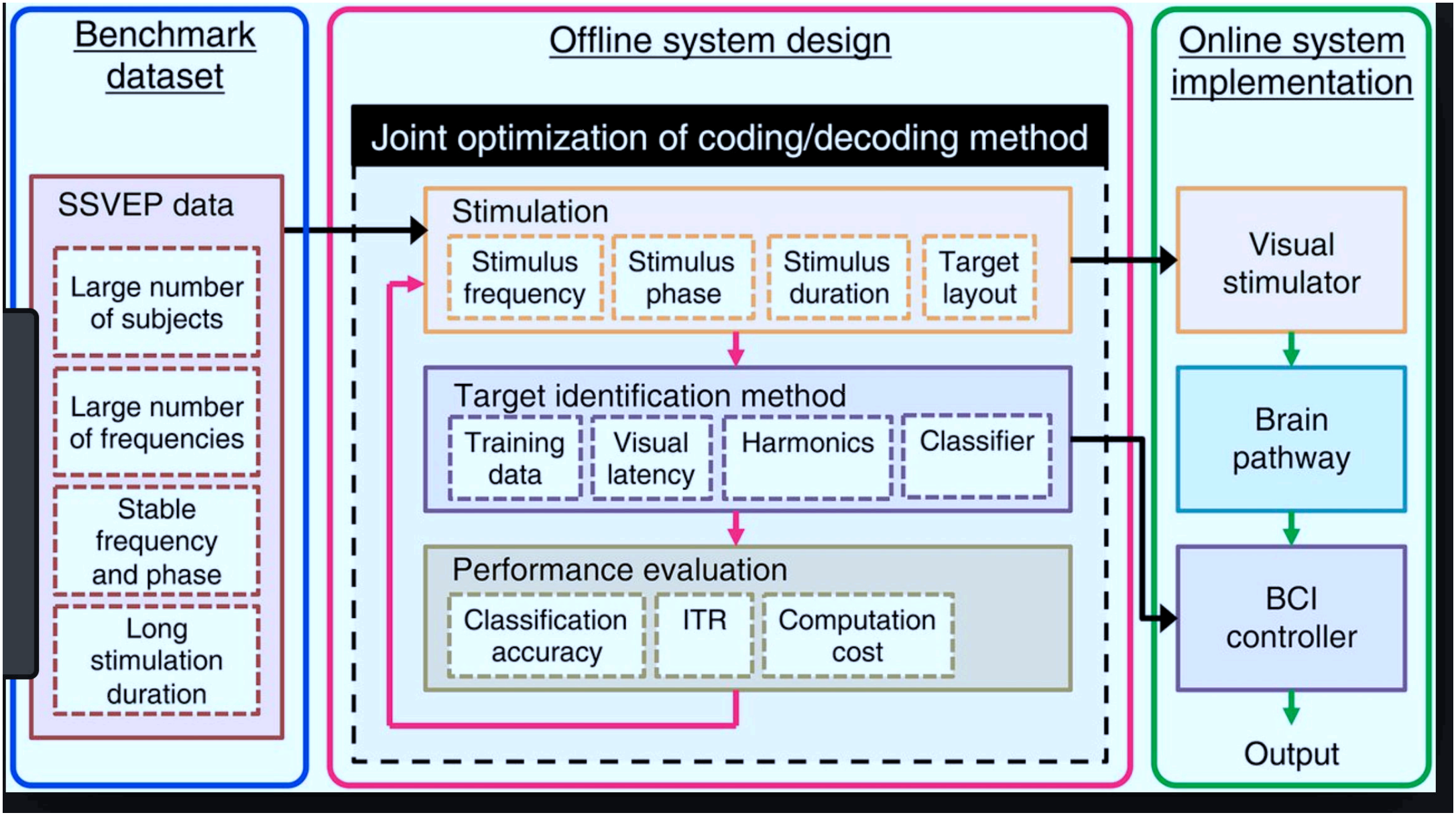

Feedback
Classification
Visual
Auditory
Feature extraction
HIGH SPEED BCI
A B C D E F G H
I J K L M N O P
Q R S T U V W X
Y Z 0 1 2 3 4 5
6 7 8 9 , . ←
Preprocessing
EEG recorder
Trigger

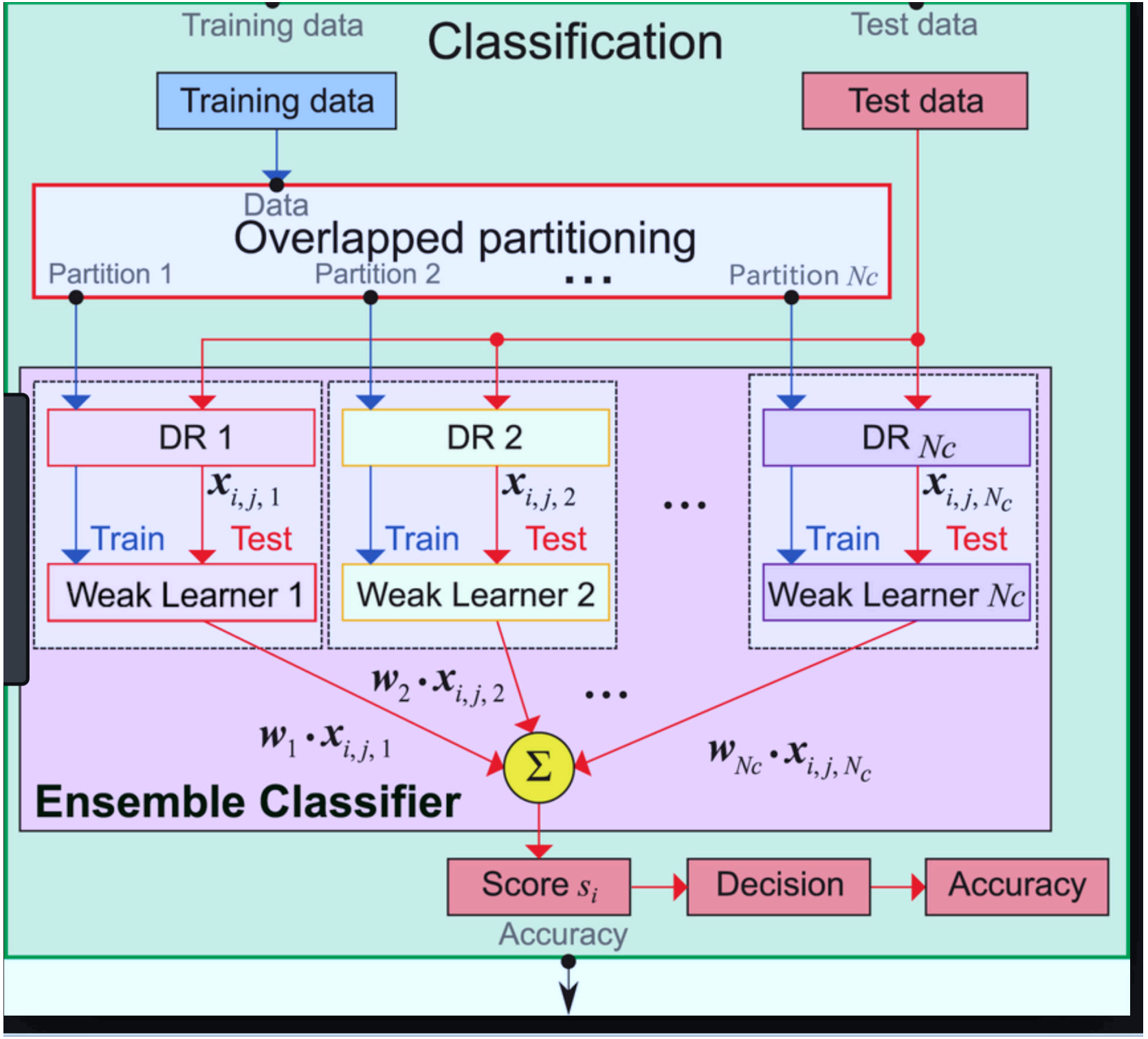

Wearable EEG Acquisition Device
PC with Bluetooth Module
EEG Acquisition Module
Bluetooth
Bluetooth Module
ADC
Amplify
Filter
Dry EEG Sensor
Bluetooth Module
BCI Archery Game
Signal Preprocessing
Focus Detection Algorithm
Update FL
EEG Signals
Feedback (the latest FL)


BrainNet BNT 36
Acquisition Equipment BrainNet-36
Main Routine PC
Brain Signals (EEG)
Pre-processing
Switch Control
Feature Extraction
MEC
CCA
MSI
Classification
Navigation Control
Class 1 11 Hz
Class 3 8 Hz
LED
Class 2 13 Hz
Class 4 15 Hz
Visual stimuli through SSVEP
Robotic Wheelchair
Sin (2πf1/ fs)
f1 = 8.0 Hz
Sin (2πf2/ fs)
f2 = 11.0 Hz
Sin (2πf3/ fs)
f3 = 13.0 Hz
Sin (2πf4/ fs)
f4 = 15.0 Hz
Cos (2πf4/ fs)
Sin (2πf4/ fs)
Cos (2πf4/ fs)
j = 2


A
Feedback
Classification
Visual
Auditory
Feature extraction
HIGH SPEED BCI
Preprocessing
EEG recorder
Trigger
B
HIGH SPEED BCI
8.0 / 0.0
9.0 / 1.75
10.0 / 1.50
11.0 / 1.25
12.0 / 1.0
13.0 / 0.75
14.0 / 0.50
15.0 / 0.25
8.2 / 0.35
9.2 / 0.10
10.2 / 1.85
11.2 / 1.60
12.2 / 1.35
13.2 / 1.10
14.2 / 0.85
15.2 / 0.60
8.4 / 0.70
9.4 / 0.45
10.4 / 0.20
11.4 / 1.95
12.4 / 1.70
13.4 / 1.45
14.4 / 1.20
15.4 / 0.95
8.6 / 1.05
9.6 / 0.80
10.6 / 0.55
11.6 / 0.30
12.6 / 0.05
13.6 / 1.80
14.6 / 1.55
15.6 / 1.30
8.8 / 1.40
9.8 / 1.15
10.8 / 0.90
11.8 / 0.65
12.8 / 0.40
13.8 / 0.15
14.8 / 1.90
15.8 / 1.65
Freq. (Hz) / Phase (π)
Attended character
H
I
0.5s black
0.5s stimulus
0.5s black
0.5s stimulus
.....
Stimulus
ϕ
15Hz(0.25π)
ϕ
8.2Hz(0.35π)
SSVEP
τ
0.5s raw data
τ
0.5s raw data
Template waveforms
Output
Correlations
H
Correlations
I

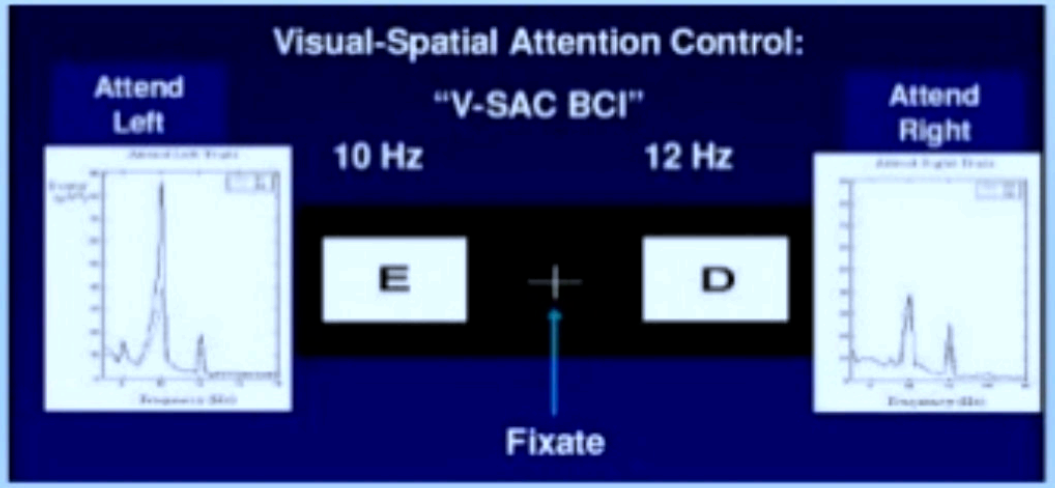

Motor Imagery
EEG Recording
Decoding, Signal processing
Feature extraction and
Classification
Natural
communication
channel broken
Control Signals
Artificial control of LL assistive devices
Muscle Control

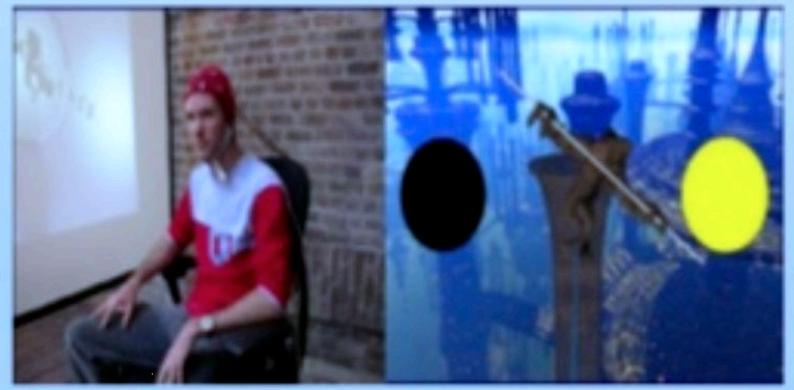

Benchmark dataset
SSVEP data
Large number of subjects
Large number of frequencies
Stable frequency and phase
Long stimulation duration
Offline system design
Joint optimization of coding/decoding method
Stimulation
Stimulus frequency
Stimulus phase
Stimulus duration
Target layout
Target identification method
Training data
Visual latency
Harmonics
Classifier
Performance evaluation
Classification accuracy
ITR
Computation cost
Online system implementation
Visual stimulator
Brain pathway
BCI controller
Output


Training data
Classification
Test data
Training data
Test data
Data
Overlapped partitioning
Partition 1
Partition 2
...
Partition Nc
DR 1
DR 2
DR Nc
$x_{i,j,1}$
$x_{i,j,2}$
$x_{i,j,Nc}$
Train
Test
Train
Test
Train
Test
Weak Learner 1
Weak Learner 2
Weak Learner Nc
...
$w_2 \cdot x_{i,j,2}$
...
$w_1 \cdot x_{i,j,1}$
$w_{Nc} \cdot x_{i,j,Nc}$
Σ
Ensemble Classifier
Score s_i
Decision
Accuracy
Accuracy

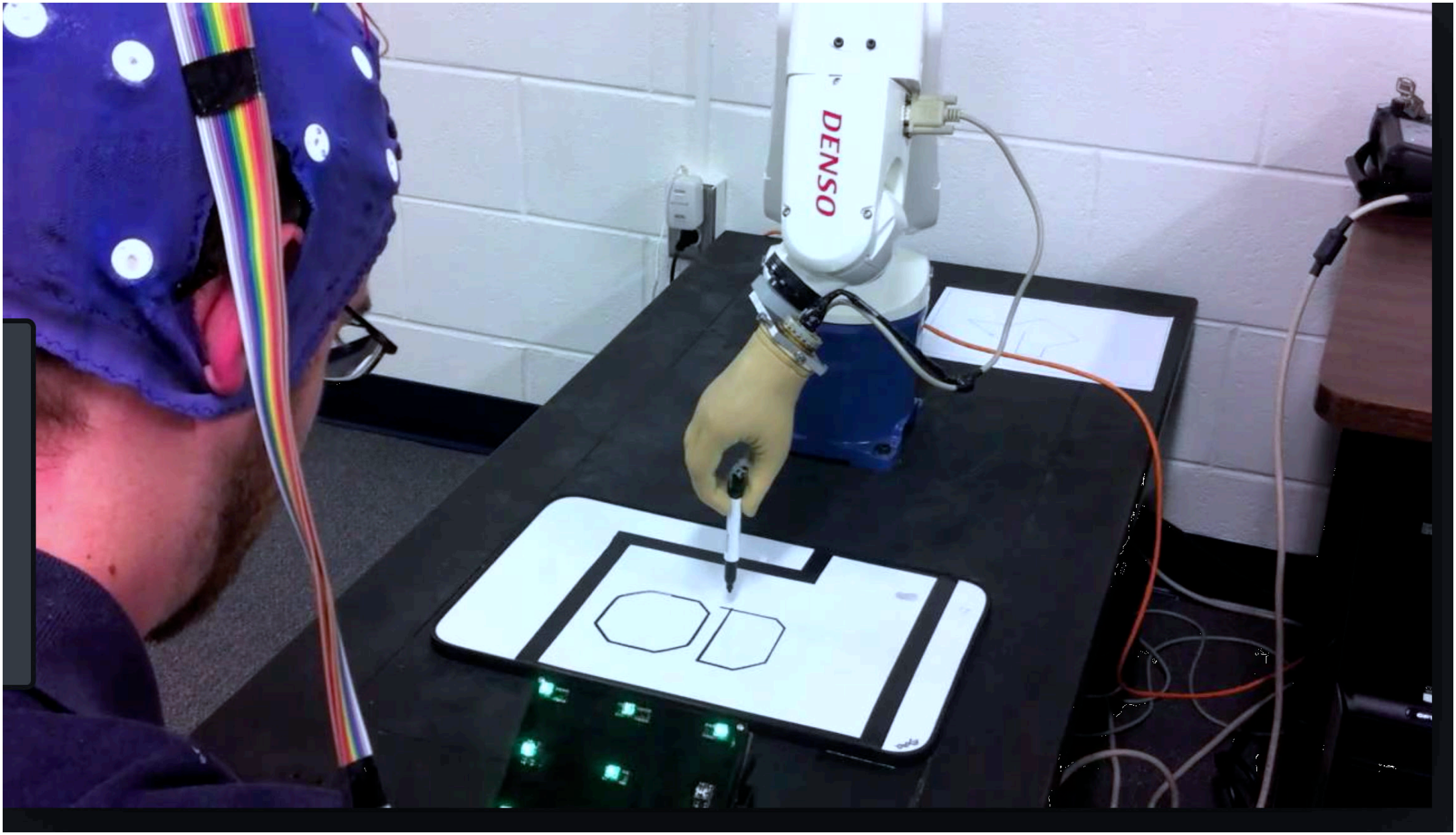
Brain Computer Interfaces – SSVEP

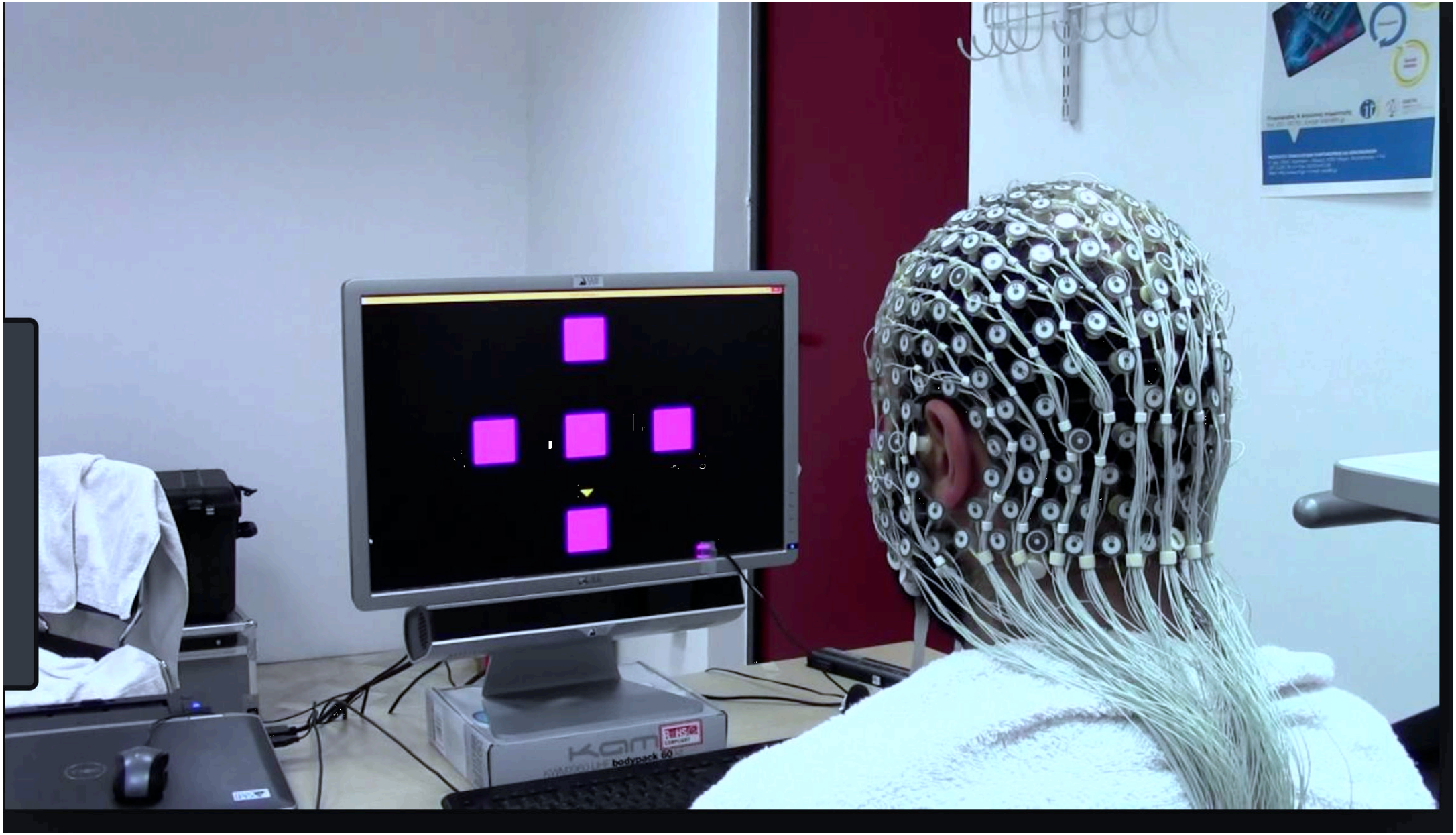
- Steady State Visual Evoked Potentials derived from the visual (occipital) cortex
- focussing attention to visual stimuli of different frequency shows up in the EEG freqeuncy bands
- relibable and high transfer rate, but some prerequisites (eyes)

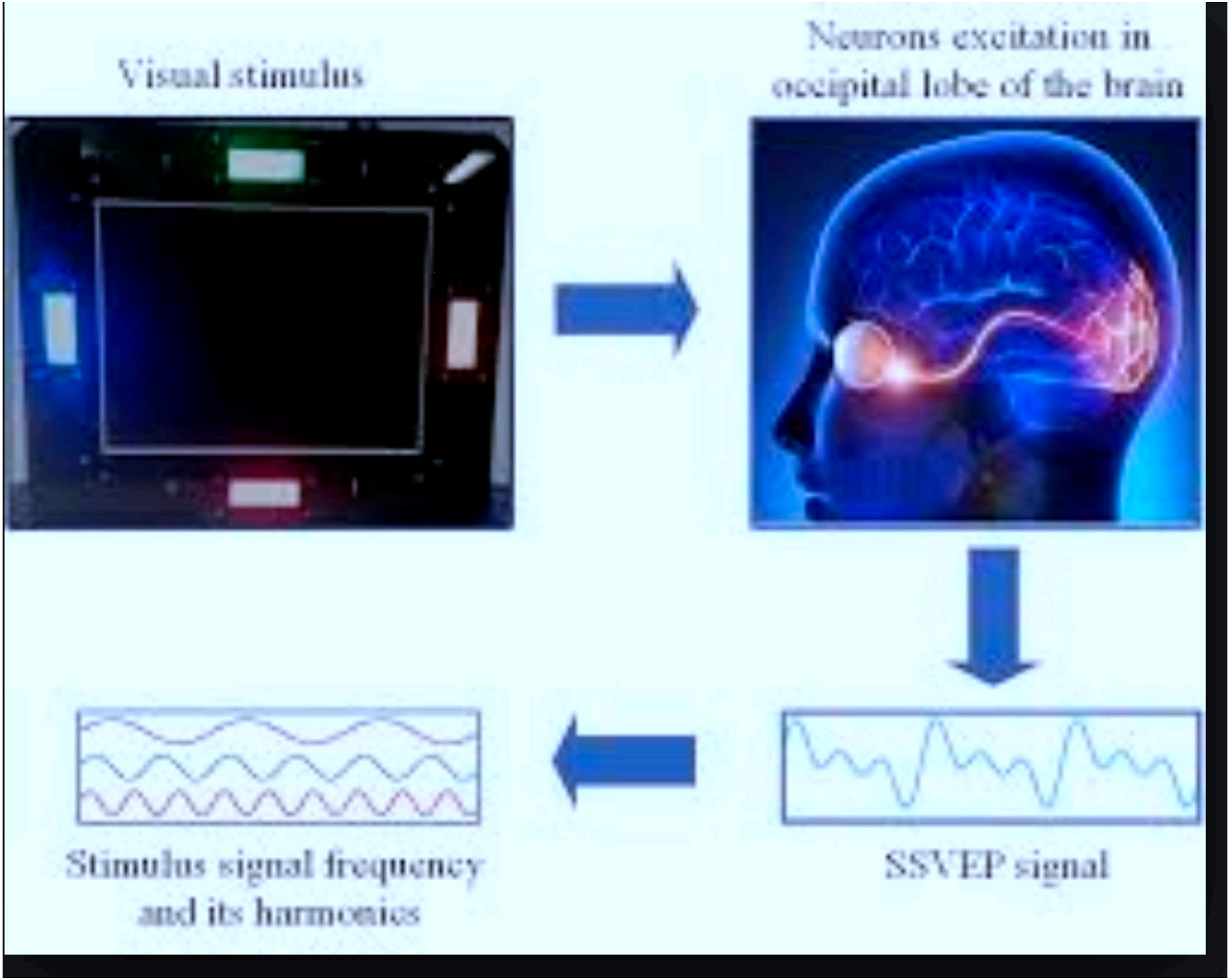


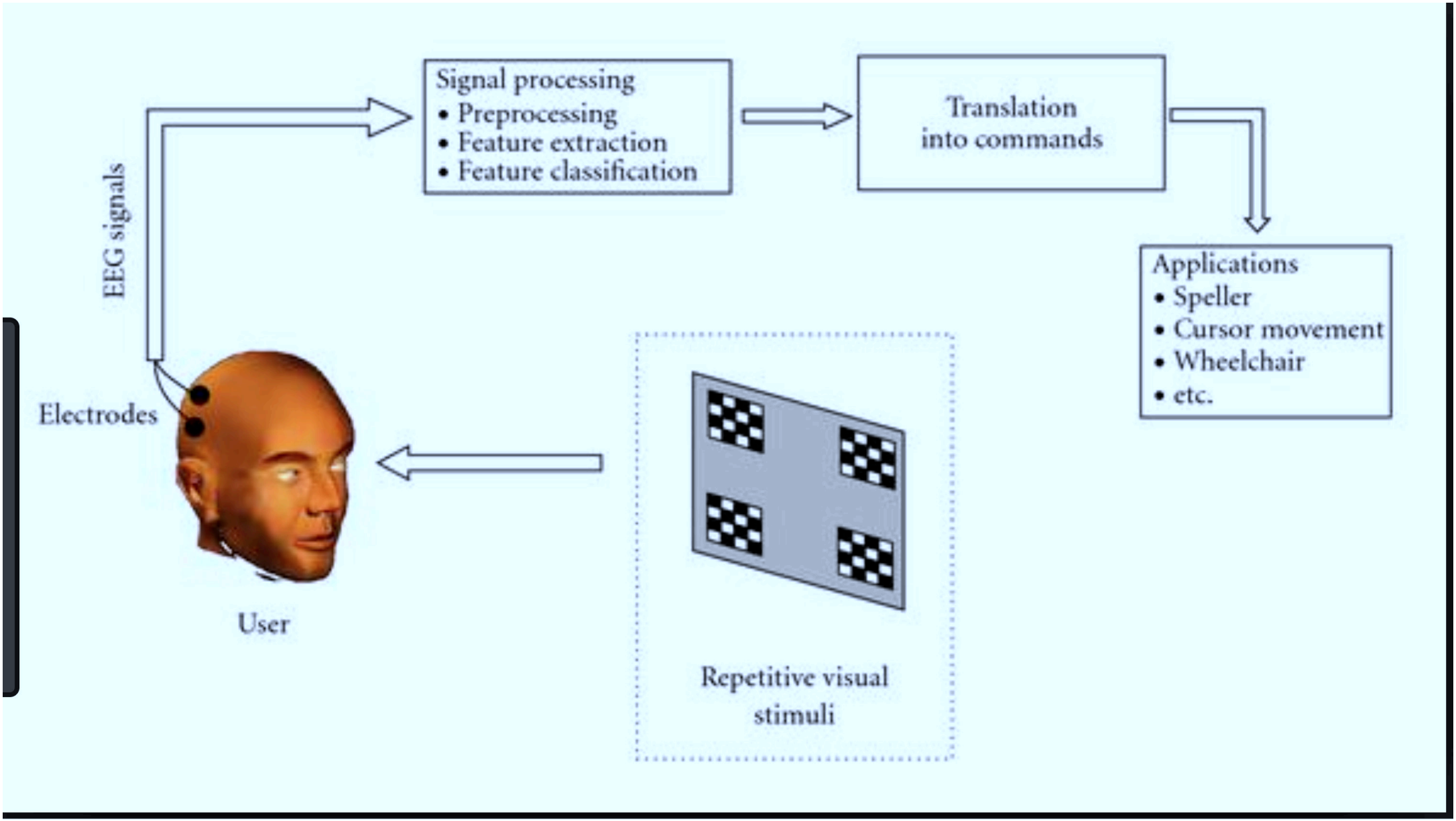


© http://www.cortechsolutions.com/Applications/BCI2000_1.aspx

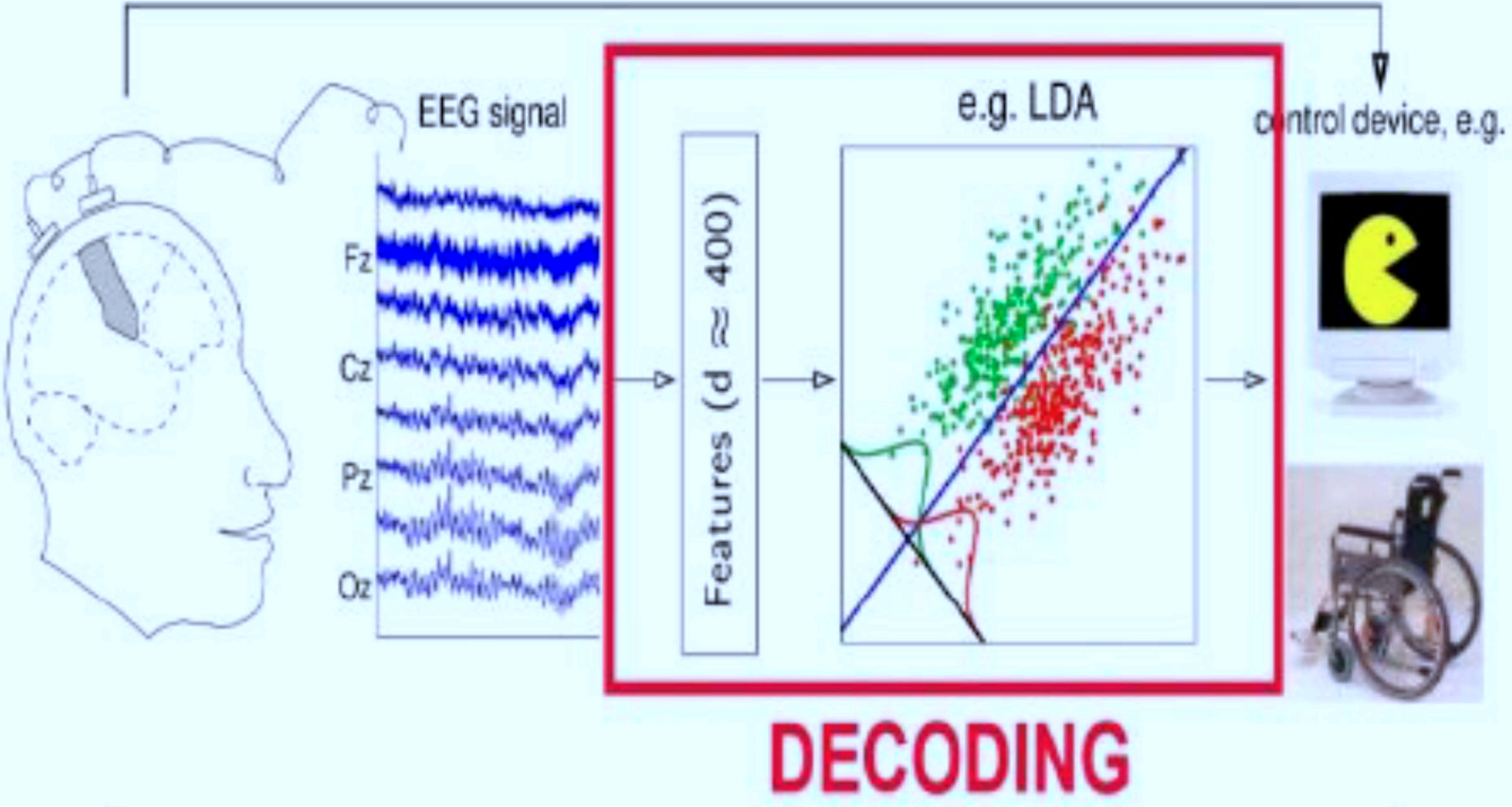

DENSO


bodypack 60


Visual stimulus
Neurons excitation in occipital lobe of the brain
SSVEP signal
Stimulus signal frequency and its harmonics

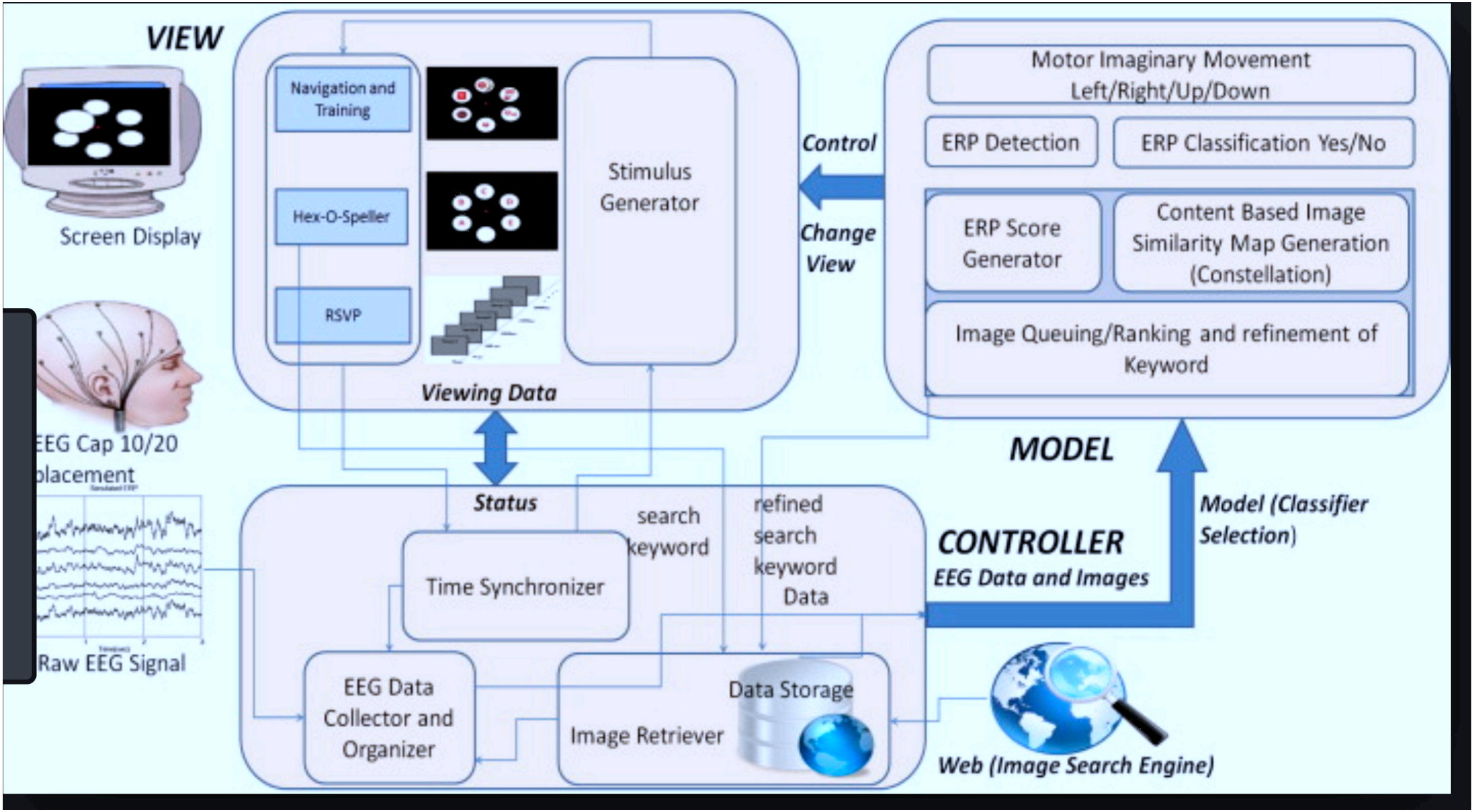

Signal processing
• Preprocessing
• Feature extraction
• Feature classification
Translation into commands
Applications
• Speller
• Cursor movement
• Wheelchair
• etc.
EEG signals
Electrodes
User
Repetitive visual stimuli

Noninvasive Brain-Computer Interface

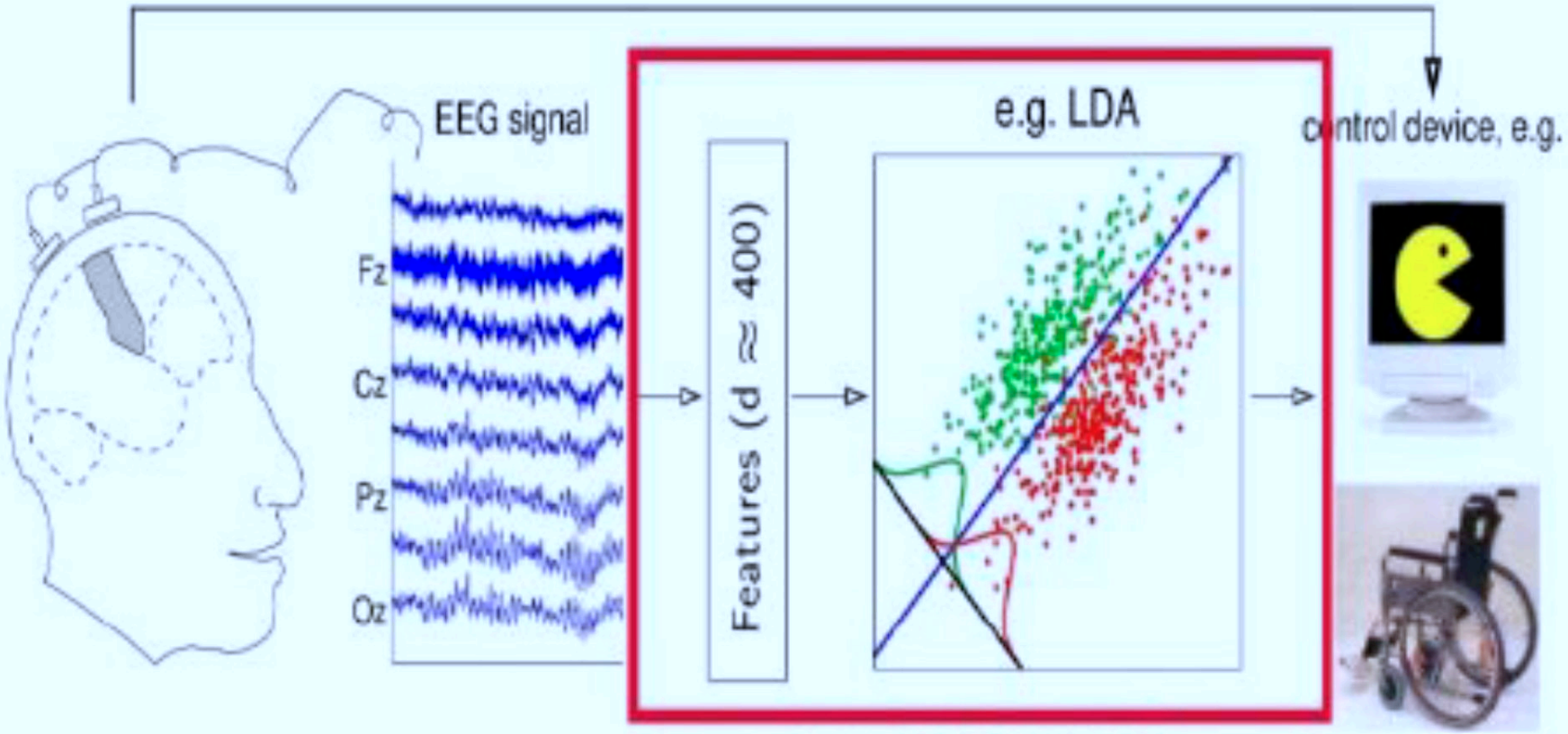


DECODING

BCI: Translation of human intentions into a technical control signal
without using activity of muscles or peripheral nerves

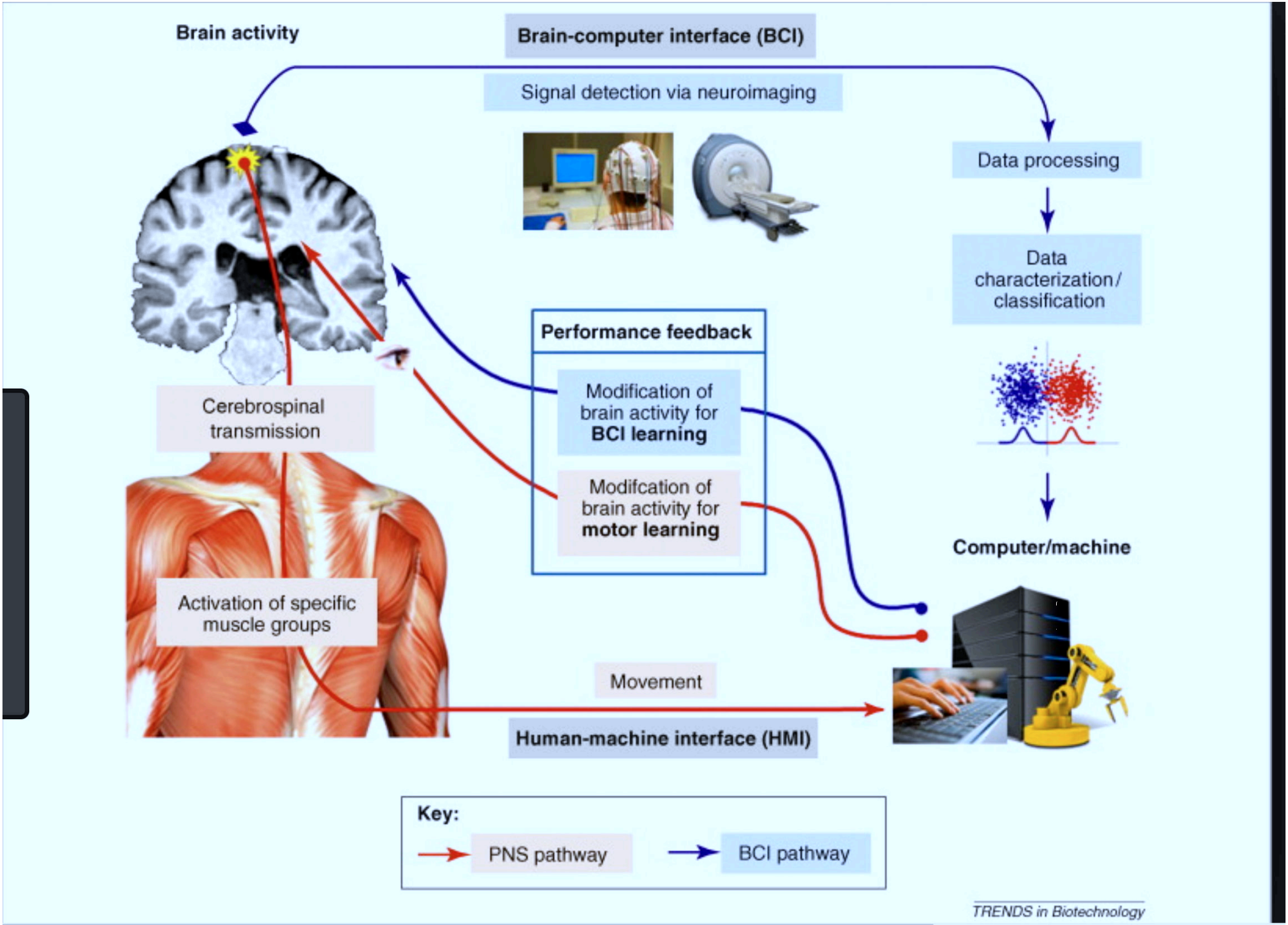

VIEW
Screen Display
EEG Cap 10/20
placement
Raw EEG Signal
Navigation and Training
Hex-O-Speller
RSVP
Stimulus Generator
Viewing Data
Control
Change View
Motor Imaginary Movement Left/Right/Up/Down
ERP Detection
ERP Classification Yes/No
ERP Score Generator
Content Based Image Similarity Map Generation (Constellation)
Image Queuing/Ranking and refinement of Keyword
MODEL
Model (Classifier Selection)
Status
search keyword
refined search keyword Data
Time Synchronizer
CONTROLLER
EEG Data and Images
EEG Data Collector and Organizer
Image Retriever
Data Storage
Web (Image Search Engine)

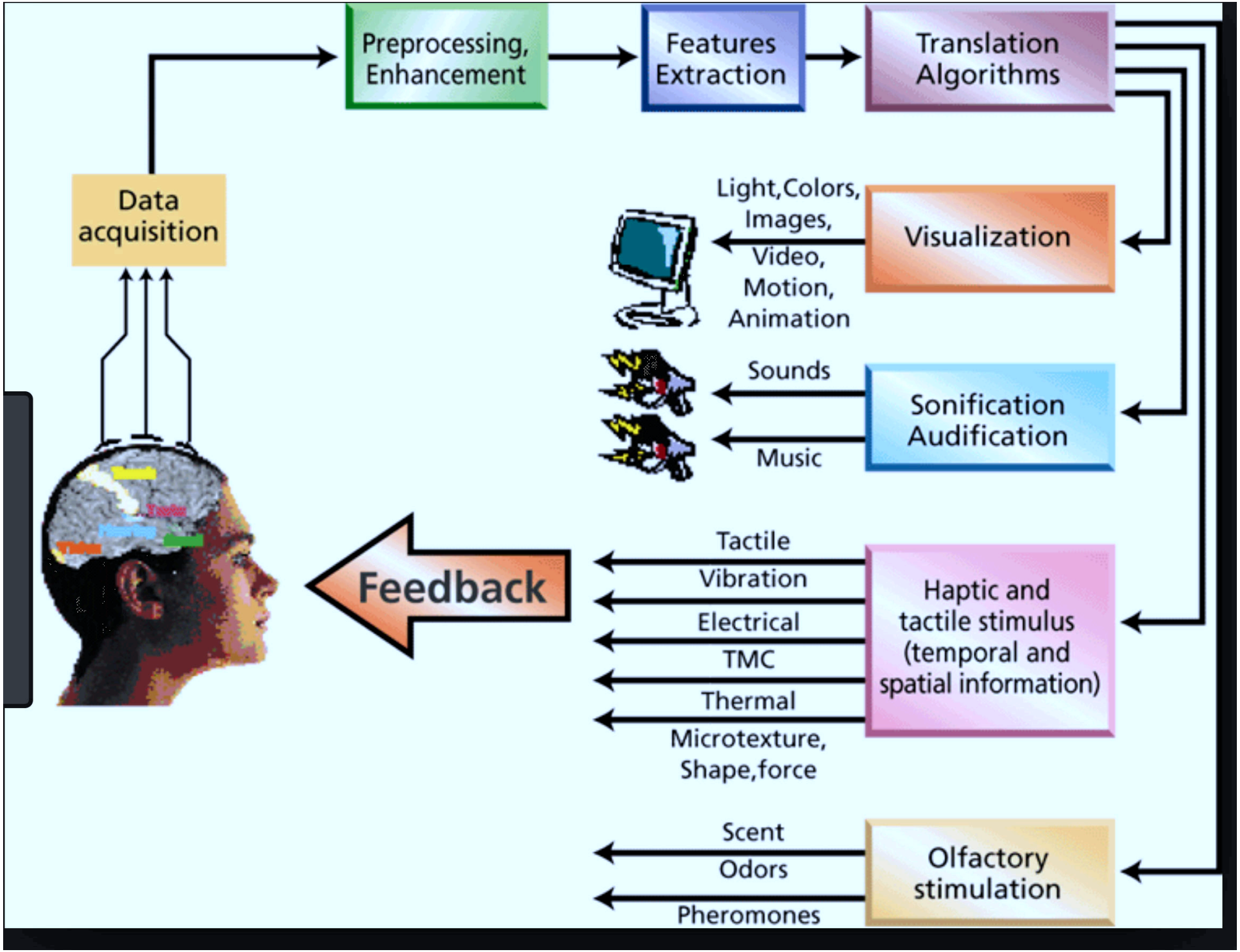
Noninvasive Brain-Computer Interface

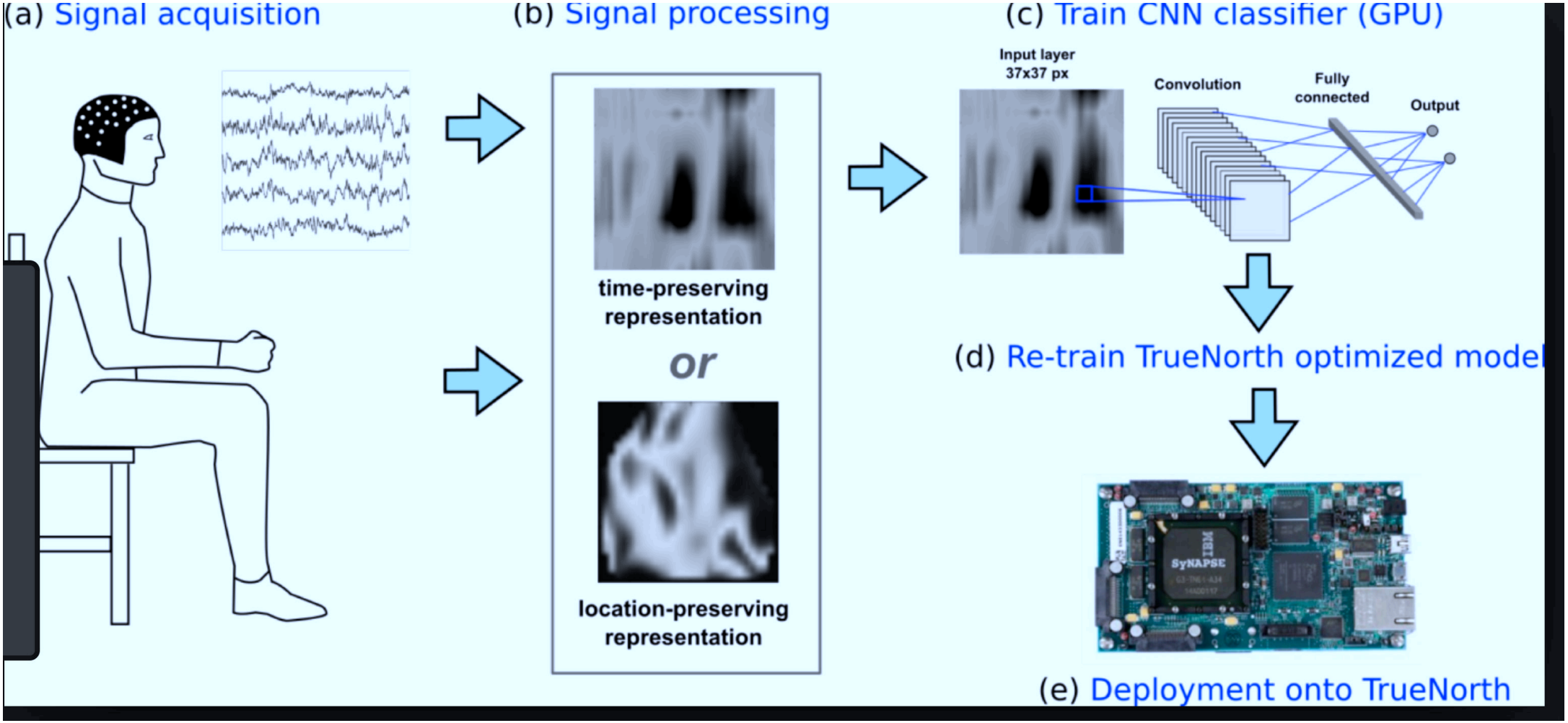


DECODING

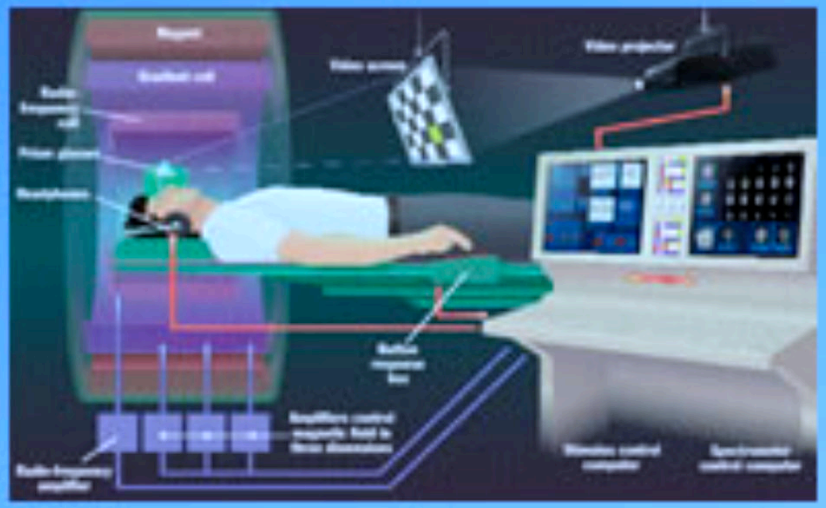
BCI: Translation of human intentions into a technical control signal
without using activity of muscles or peripheral nerves


Brain activity
Brain-computer interface (BCI)
Signal detection via neuroimaging
Data processing
Data characterization / classification
Performance feedback
Modification of brain activity for BCI learning
Modifcation of brain activity for motor learning
Cerebrospinal transmission
Activation of specific muscle groups
Computer/machine
Movement
Human-machine interface (HMI)
Key:
PNS pathway
BCI pathway
TRENDS in Biotechnology

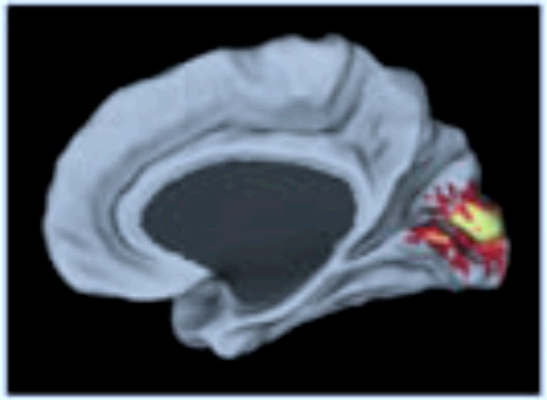

Preprocessing, Enhancement
Features Extraction
Translation Algorithms
Data acquisition
Light,Colors, Images, Video, Motion, Animation
Visualization
Sounds
Music
Sonification Audification
Feedback
Tactile
Vibration
Electrical
TMC
Thermal
Microtexture, Shape,force
Haptic and tactile stimulus (temporal and spatial information)
Scent
Odors
Pheromones
Olfactory stimulation

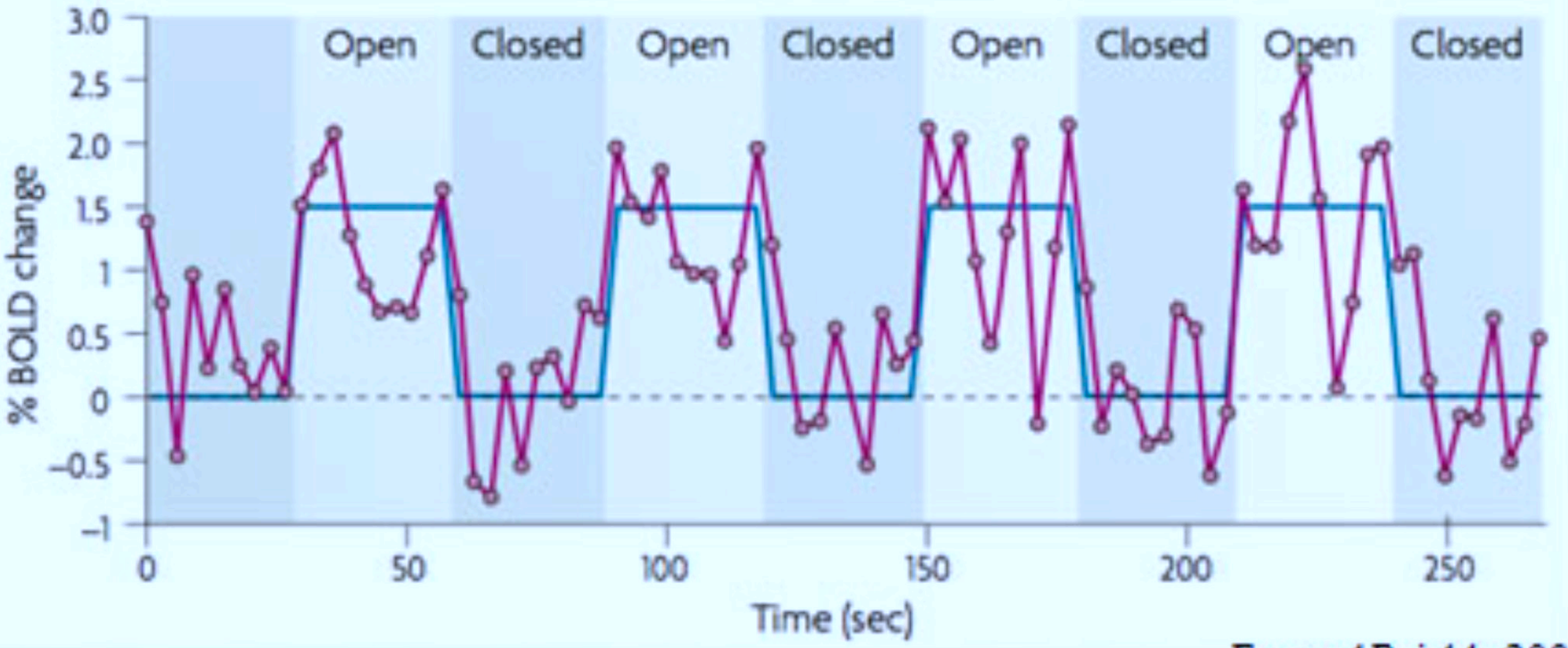

(a) Signal acquisition
(b) Signal processing
(c) Train CNN classifier (GPU)
time-preserving representation
or
location-preserving representation
Input layer 37x37 px
Convolution
Fully connected
Output
(d) Re-train TrueNorth optimized model
SyNAPSE
(e) Deployment onto TrueNorth

Functional MRI

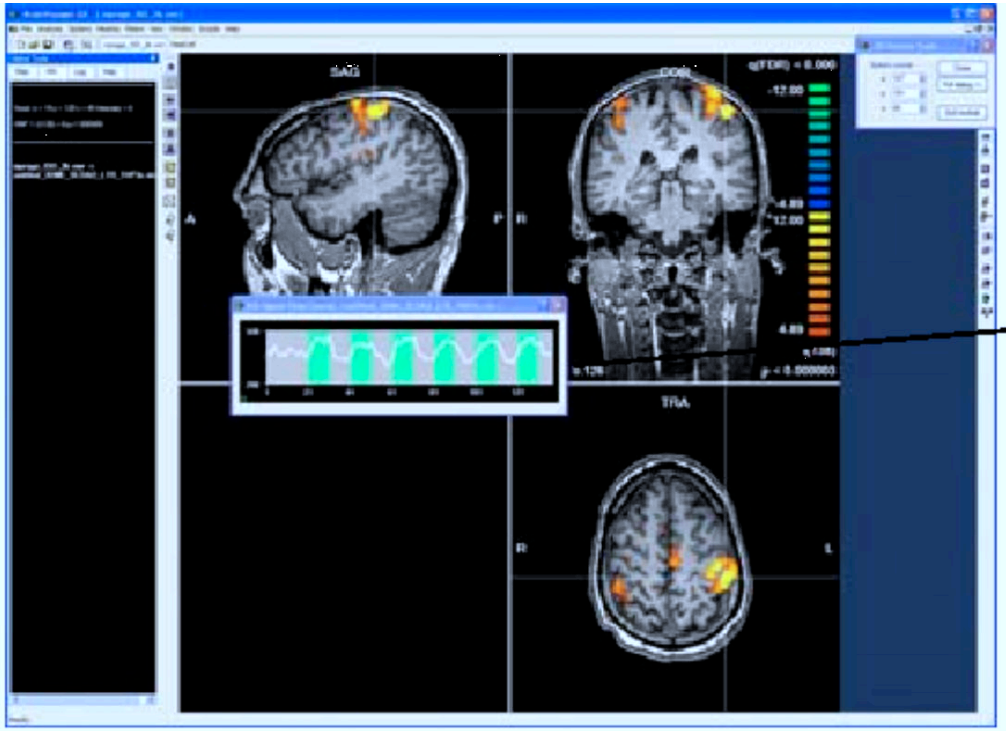


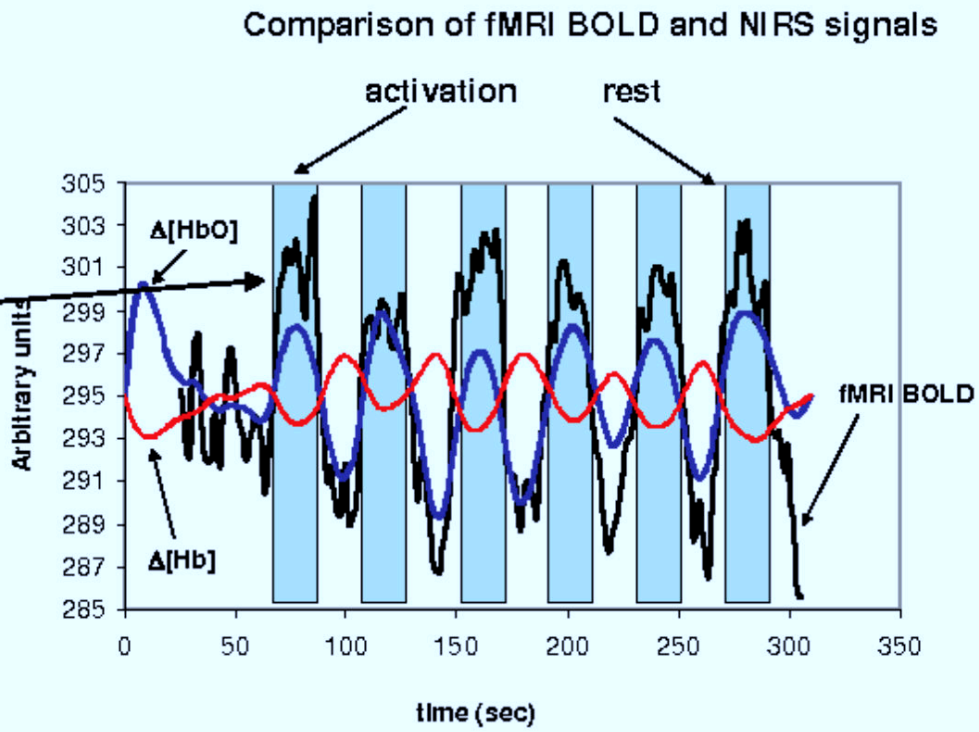
Open – Closed =

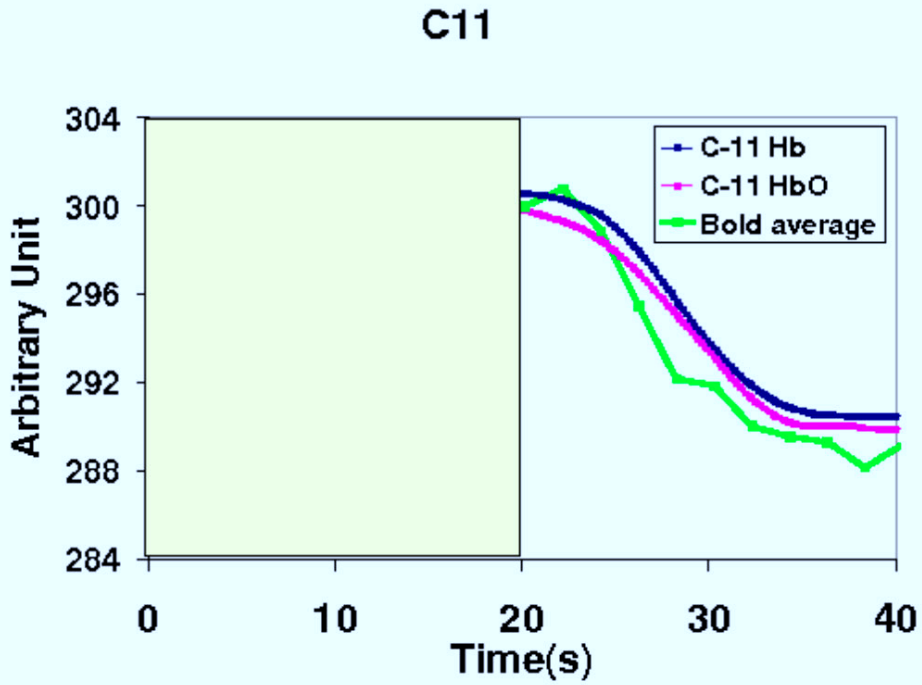


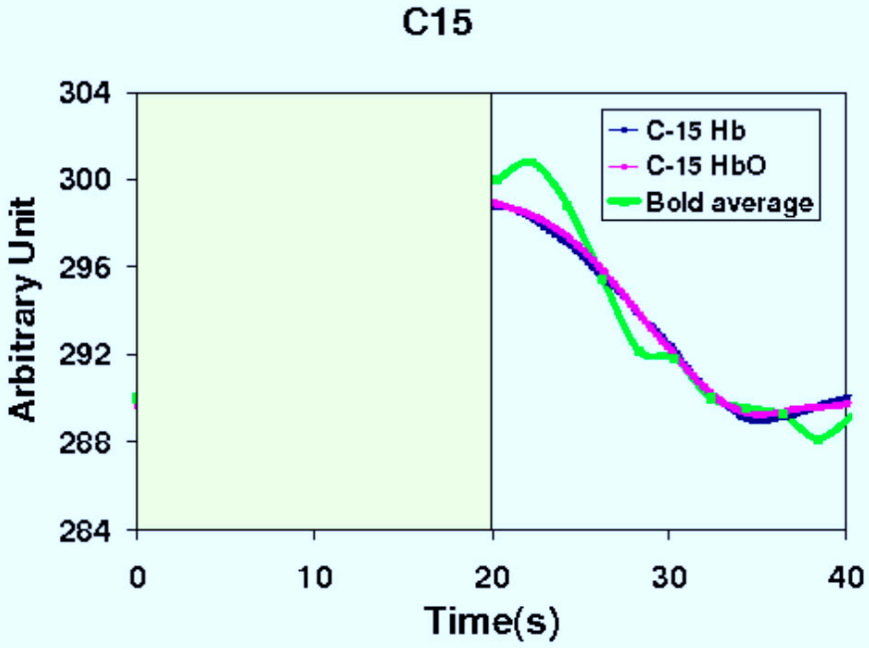


Fox and Raichle 2007

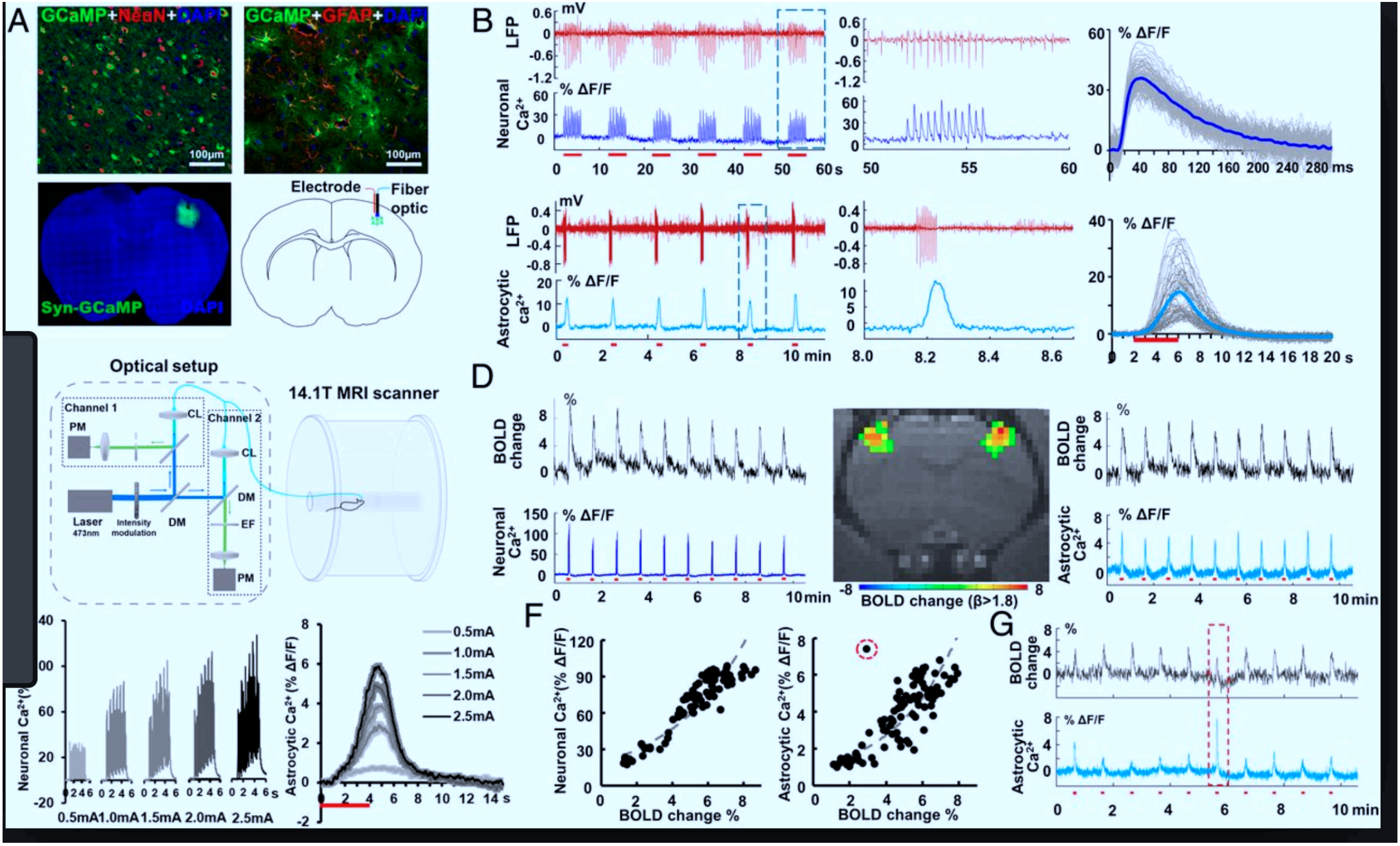


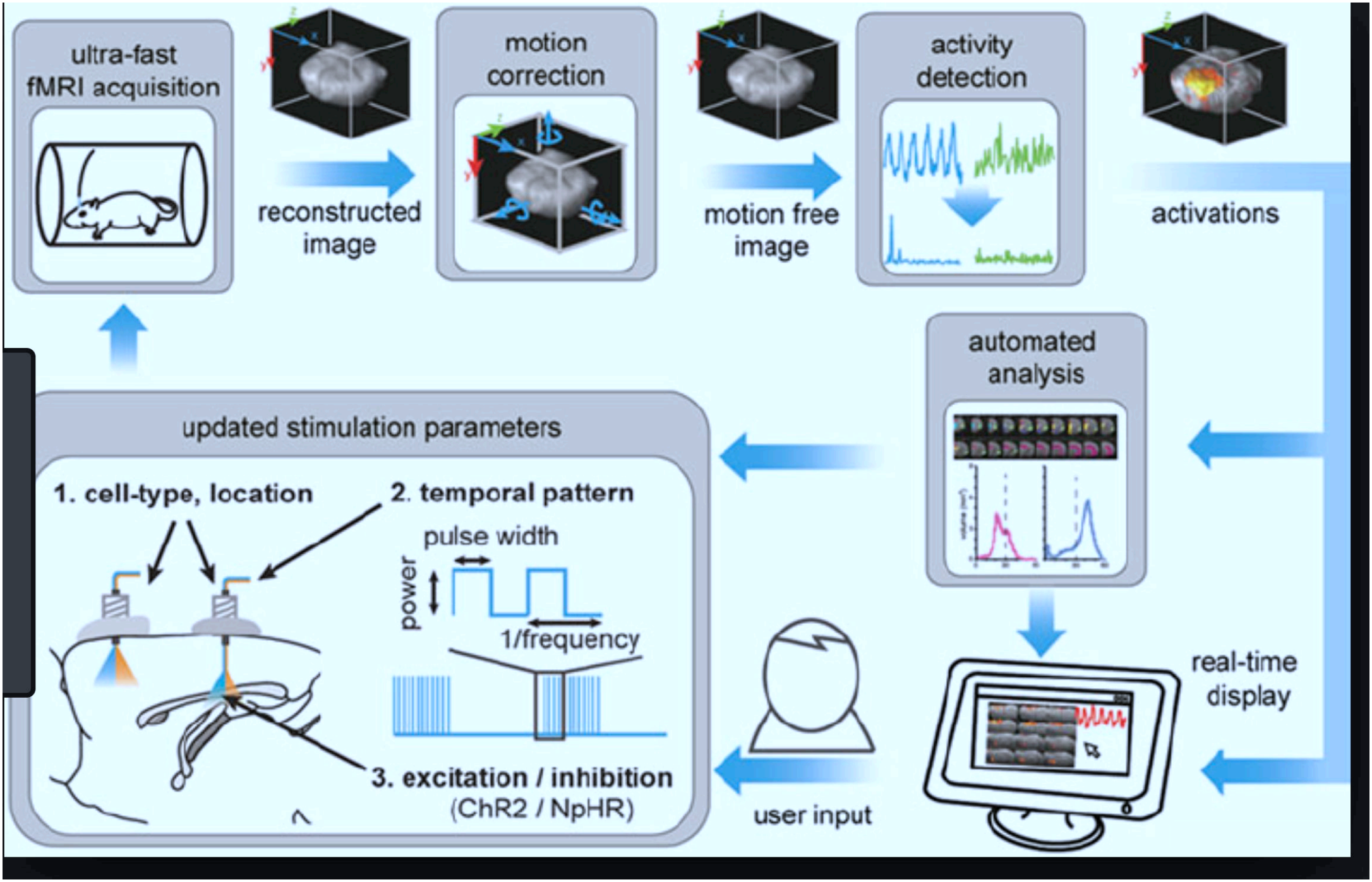


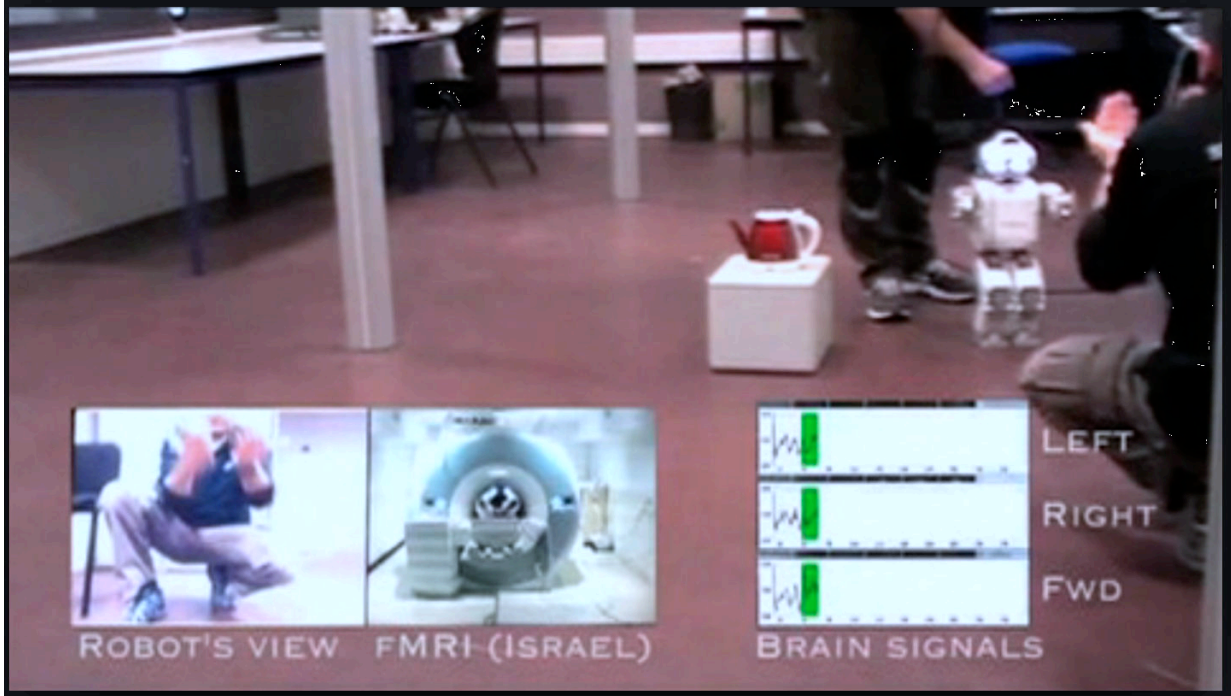




Comparison of the spatial and temporal features of the fMRI BOLD signal and the NIRS-measured changes in oxy


A
GCaMP+NeuN+DAPI
GCaMP+GFAP+DAPI
100μm
100μm
Syn-GCaMP
DAPI
Electrode
Fiber optic
B
LFP
mV
Neuronal Ca2+
% ΔF/F
Astrocytic ca2+
10 min
60 s
ms
s
Optical setup
14.1T MRI scanner
Channel 1
Channel 2
PM
CL
DM
EF
Laser 473nm
Intensity modulation
D
BOLD change
BOLD change (β>1.8)
F
Neuronal Ca2+(% ΔF/F)
Astrocytic Ca2+(% ΔF/F)
BOLD change %
0.5mA
1.0mA
1.5mA
2.0mA
2.5mA
G


ultra-fast
fMRI acquisition
reconstructed
image
motion
correction
motion free
image
activity
detection
activations
automated
analysis
real-time
display
user input
updated stimulation parameters
1. cell-type, location
2. temporal pattern
pulse width
power
1/frequency
3. excitation / inhibition
(ChR2 / NpHR)



590 × 894 - Images may be subject to copyright. Learn More

Real-life Avatar: Th

ExtremeTech

Controlling a robot surrogate, w

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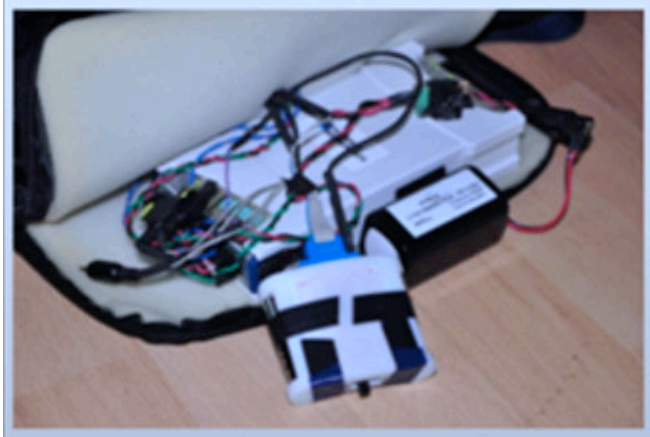
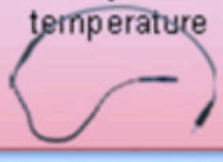
Data Acquisition Bag:
The bag contains the measurements and NI devices.



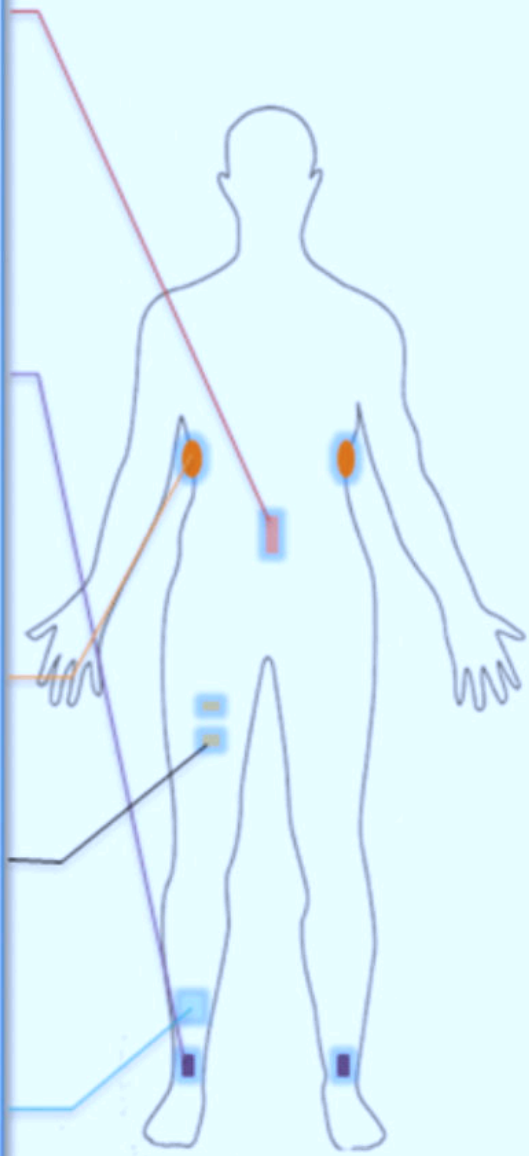
The bag can be carried as a backpack or waist pack.

ECG and EMG Amplifier:
The electrodes are connected to the amplifier via a DE-9 connector.

Temperature Sensor:
Position on the back to measure body skin temperature



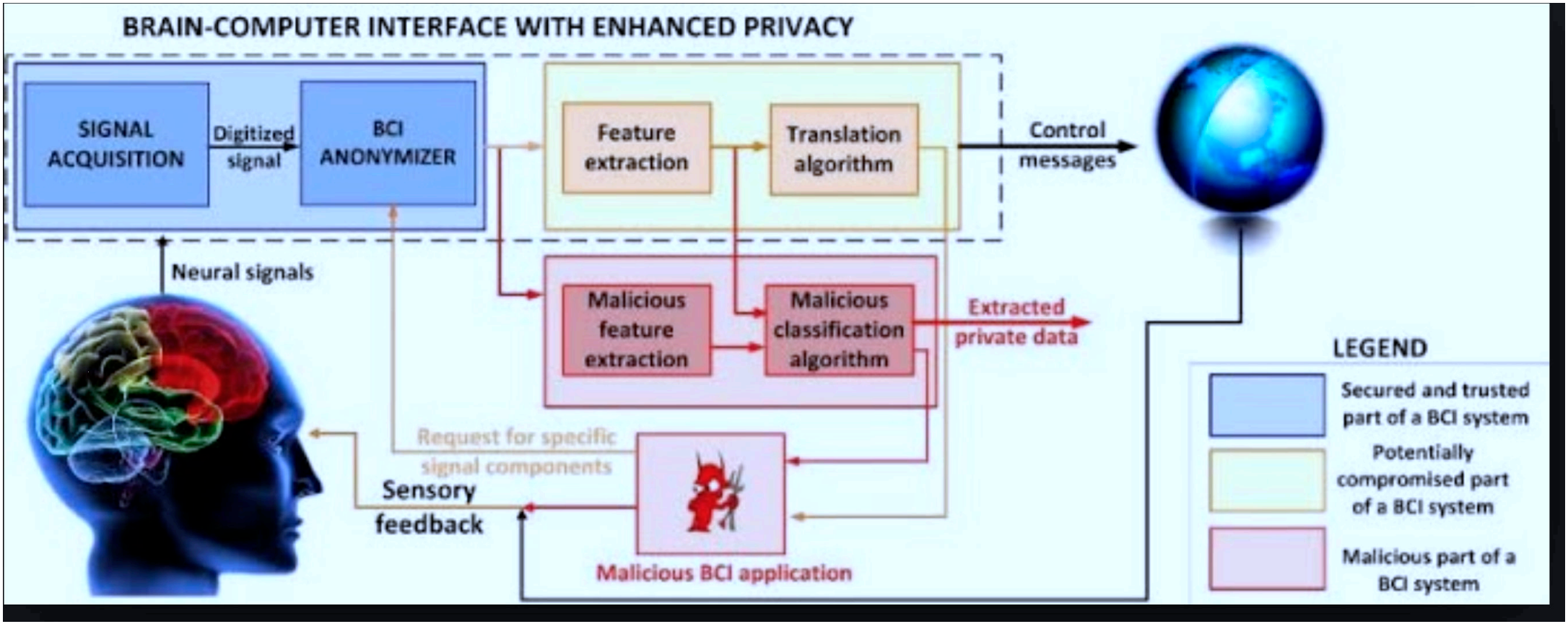
Motion Sensors:
Measure motions of each feet

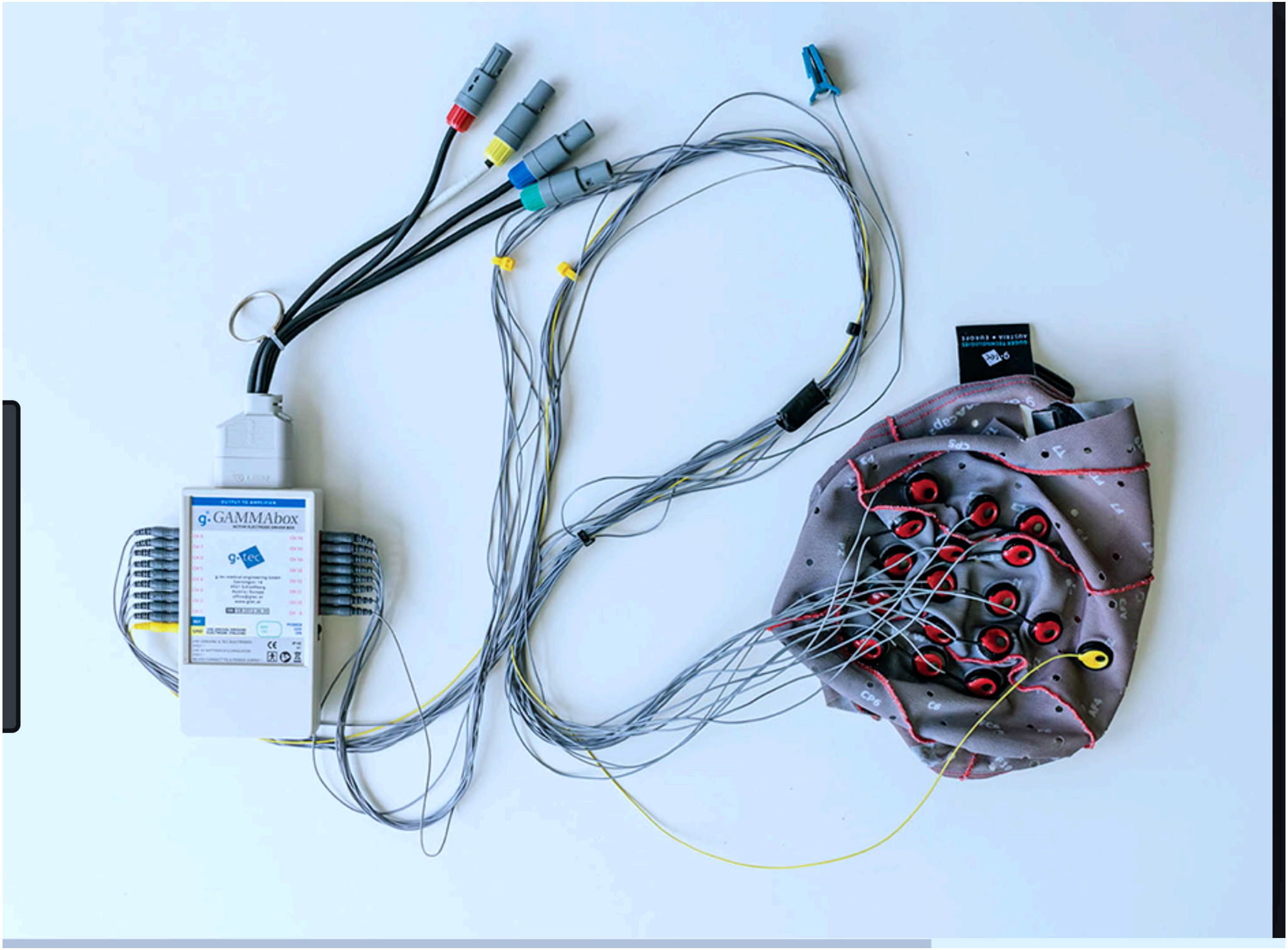


ECG Electrodes:
Position on the sides of thorax under the arms.

EMG Electrodes:
Position on quadriceps and on face to measure muscle activity and eye movement during day time and over night respectively.

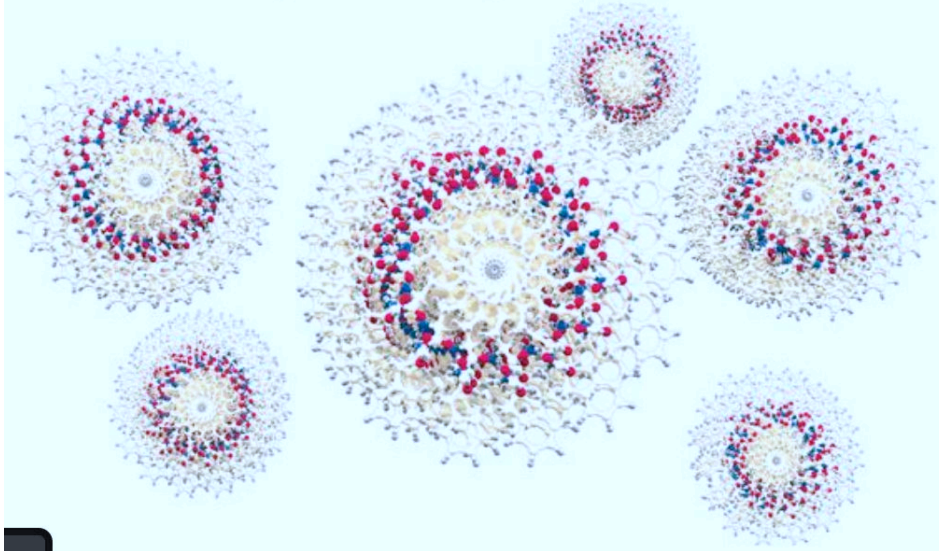
Neuroline Ground:
Position on right shank for the Driven-Right-Leg system


BRAIN-COMPUTER INTERFACE WITH ENHANCED PRIVACY
SIGNAL ACQUISITION
Digitized signal
BCI ANONYMIZER
Feature extraction
Translation algorithm
Control messages
Neural signals
Malicious feature extraction
Malicious classification algorithm
Extracted private data
Request for specific signal components
Sensory feedback
Malicious BCI application
LEGEND
Secured and trusted part of a BCI system
Potentially compromised part of a BCI system
Malicious part of a BCI system

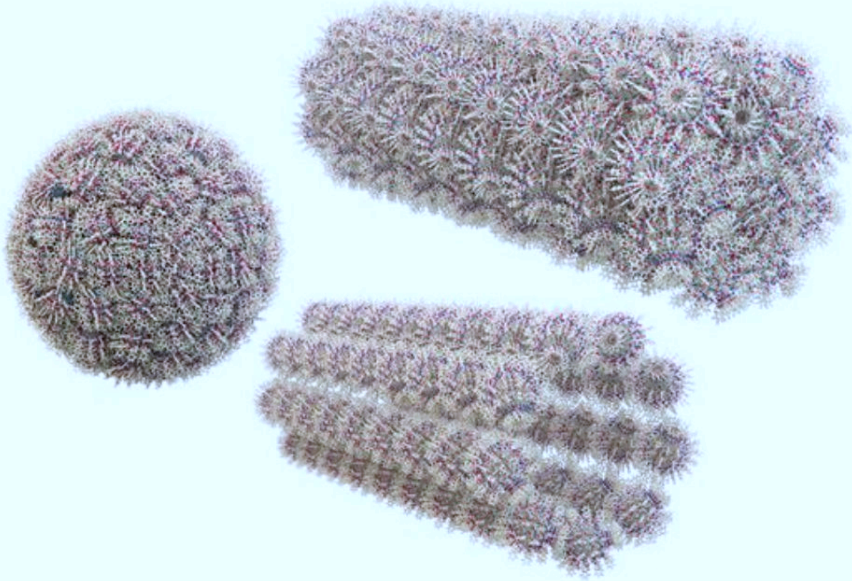

g.GAMMAbox
g.tec

Oligomerized quantum dots

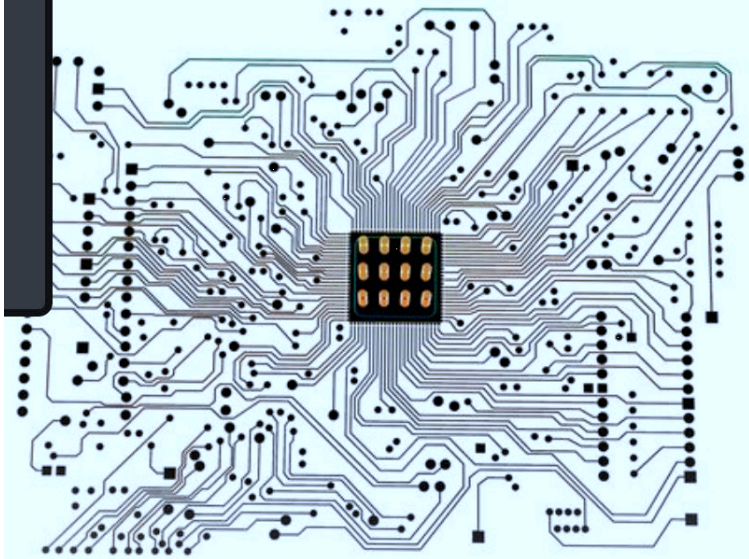
Quantum confined supramolecular structures



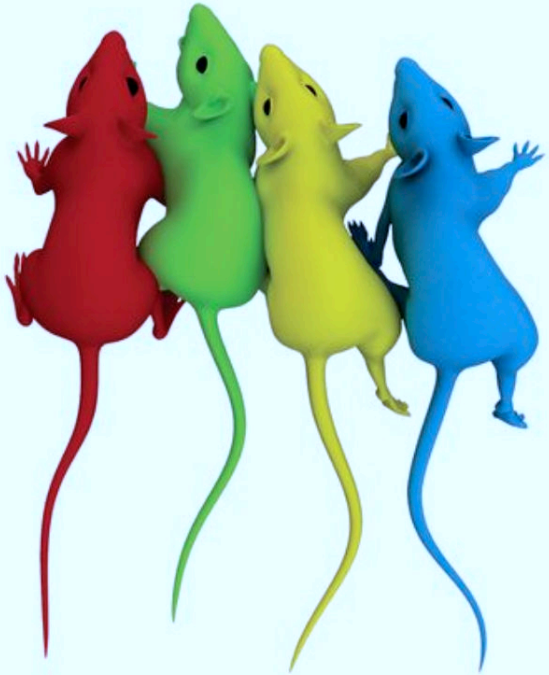
Self-assembly



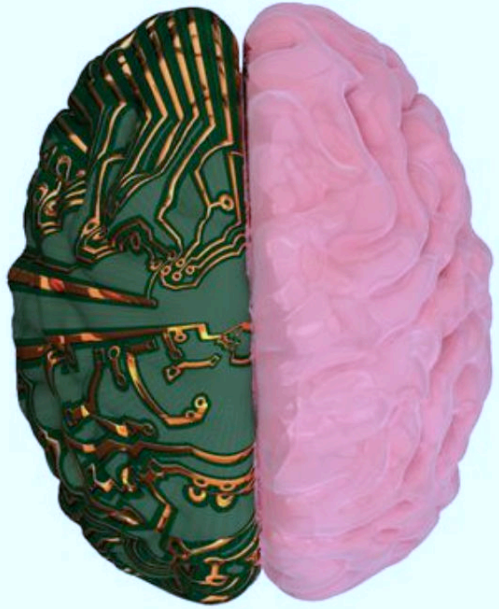
Bioinspired semiconductors

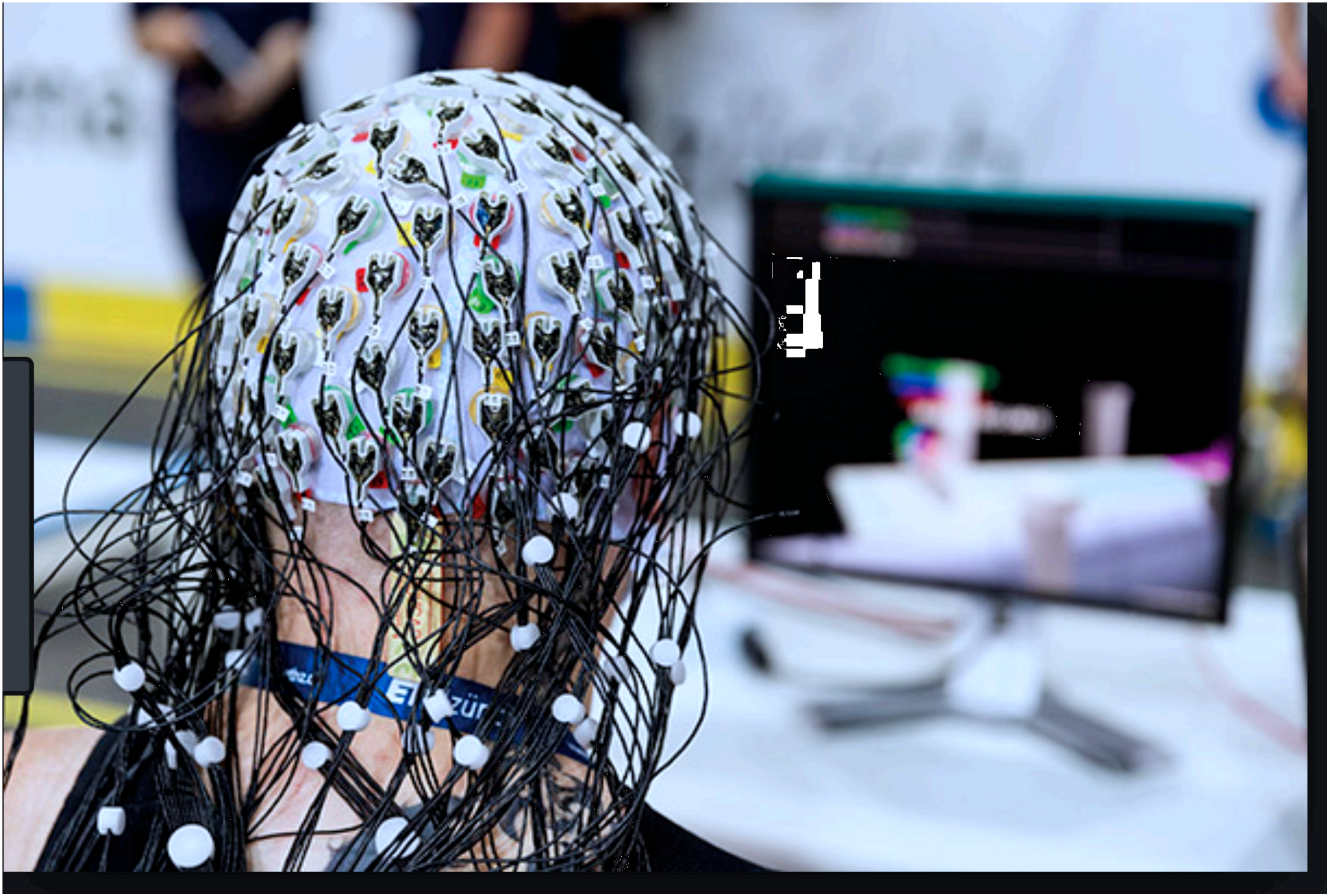


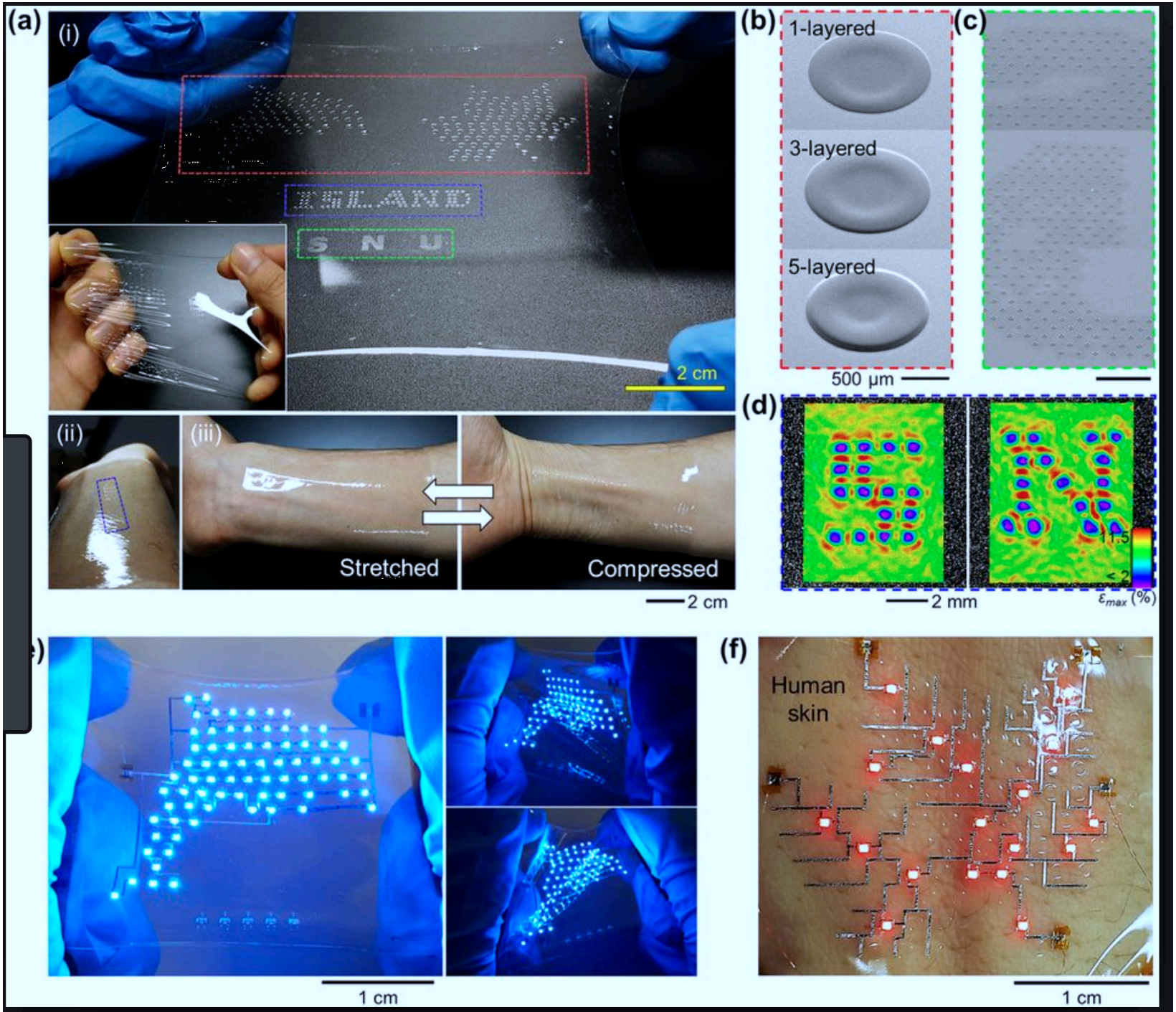
Real-time bioimaging and diagnosis



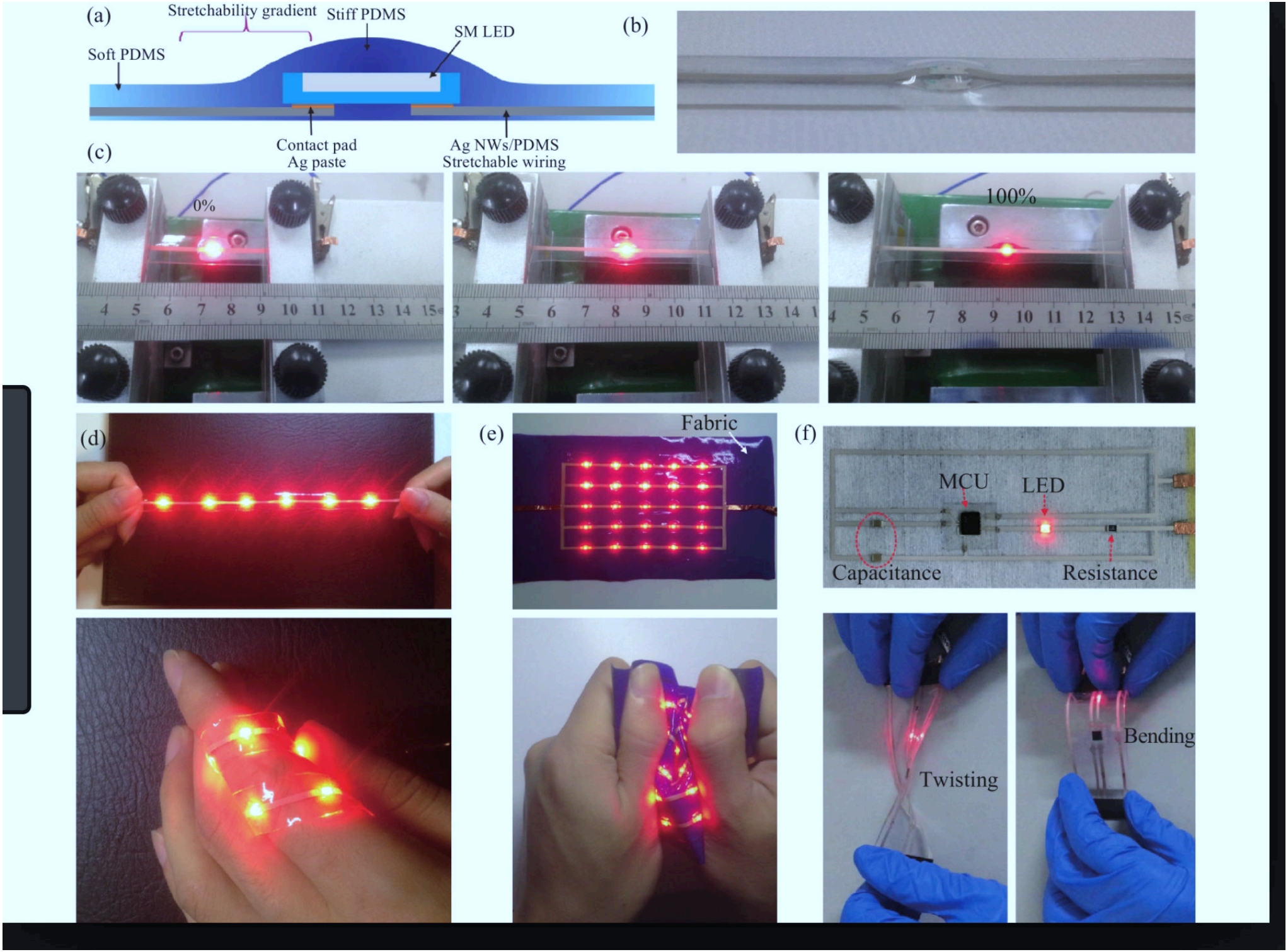
Bio-machine interface

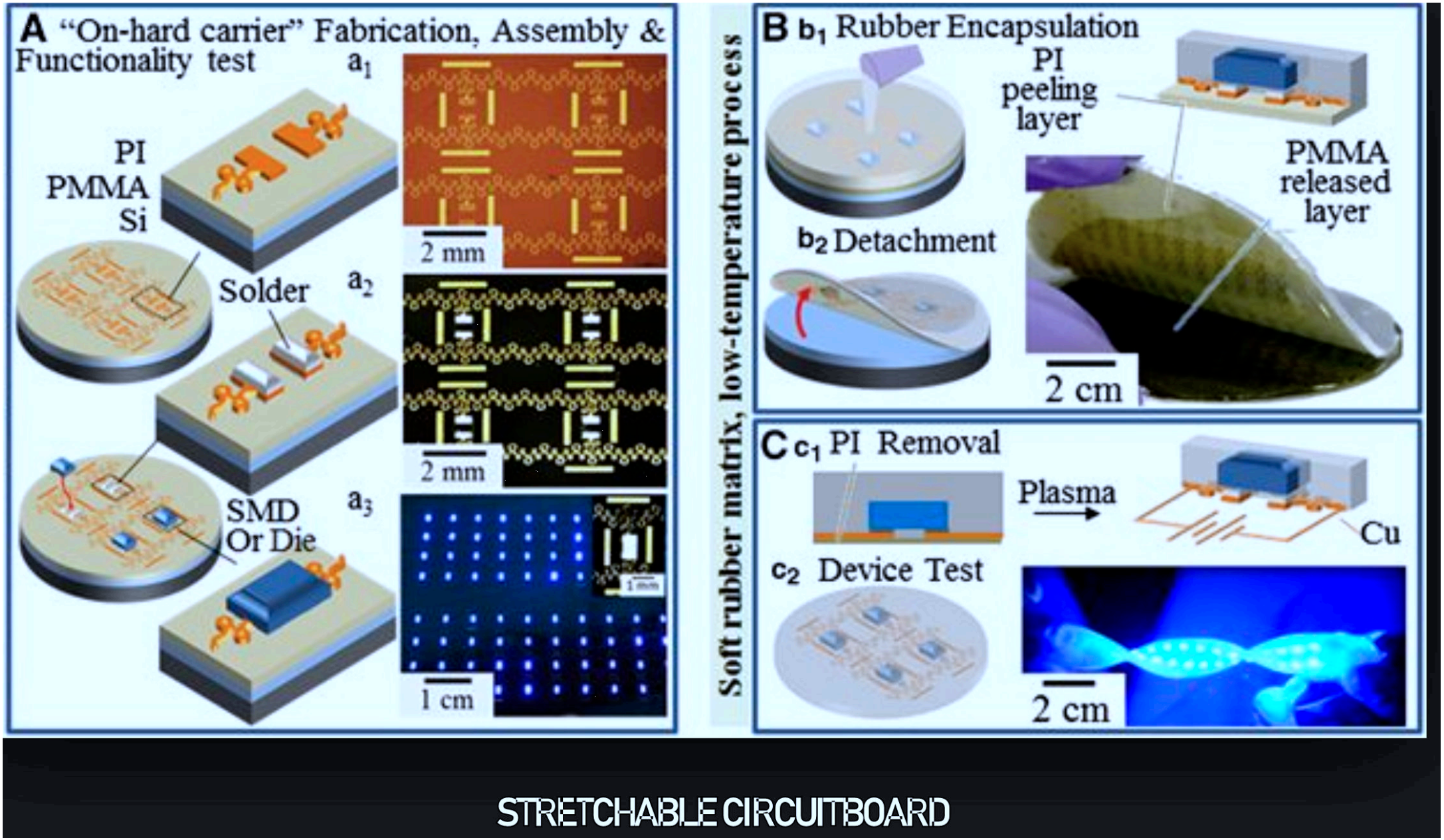




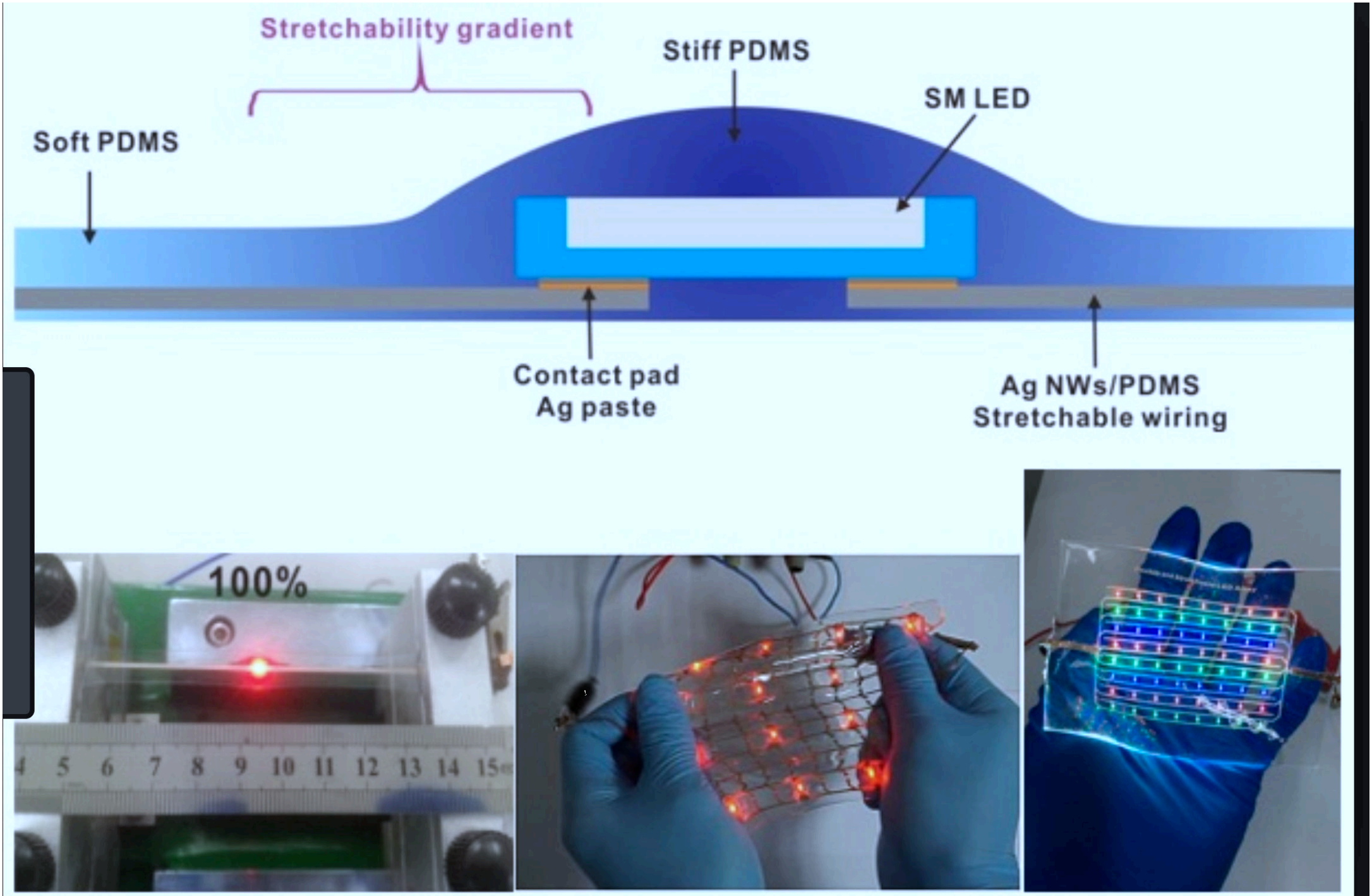


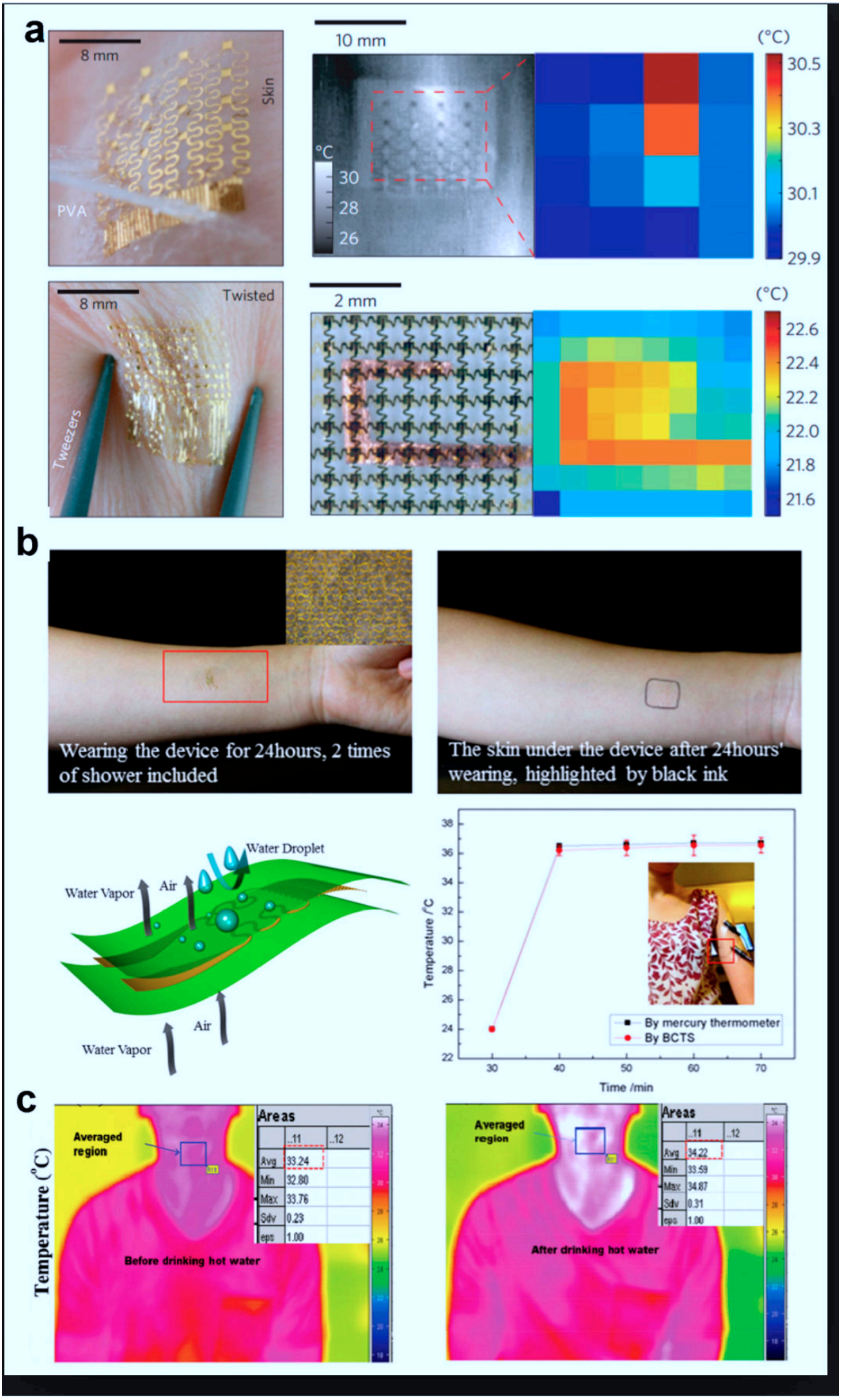
STRAIN ENGINEERED ELECTRONIC WRAP

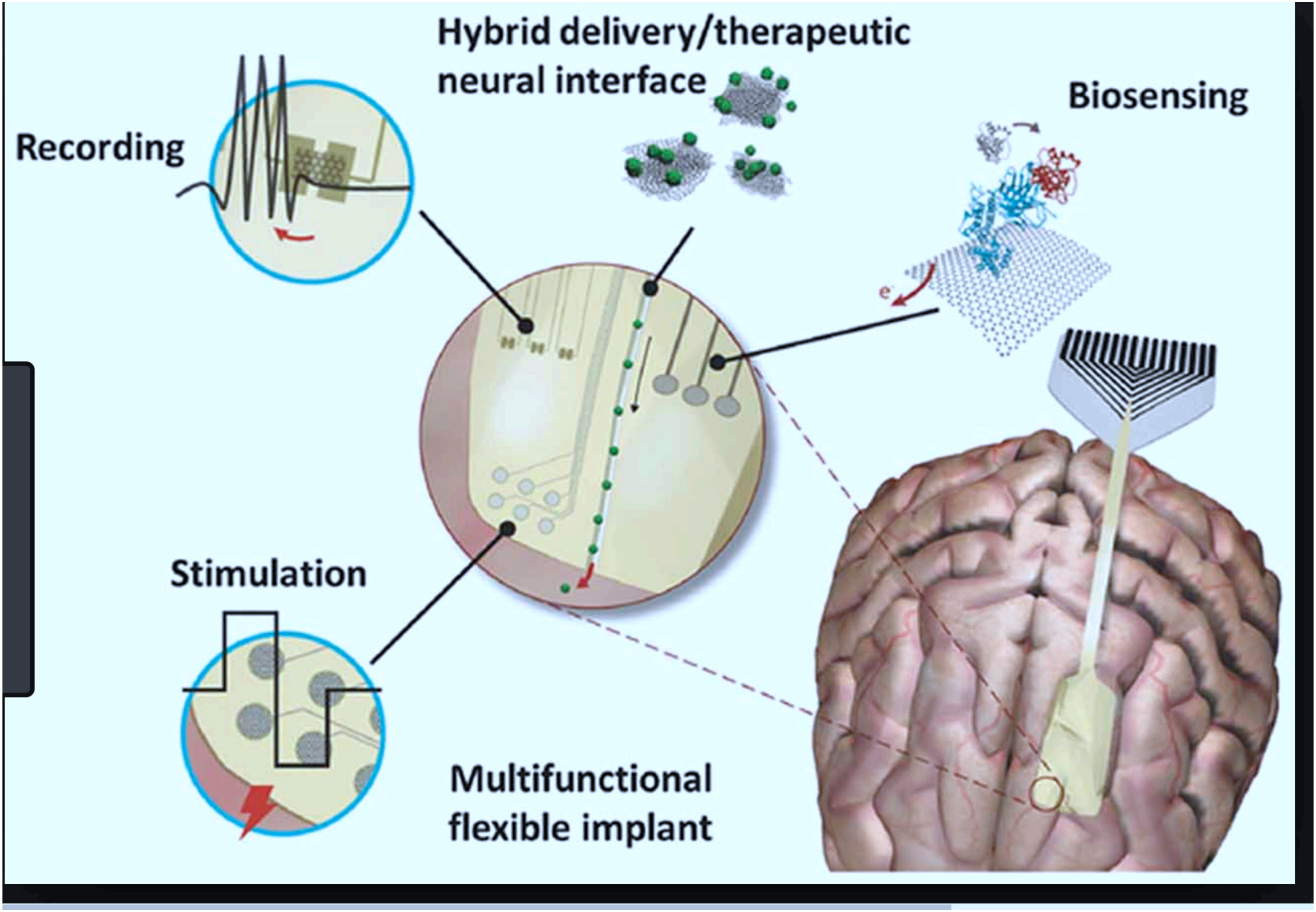

(a)
Stretchability gradient
Stiff PDMS
SM LED
Soft PDMS
Contact pad
Ag paste
Ag NWs/PDMS
Stretchable wiring
(b)
(c)
0%
100%
(d)
(e)
Fabric
(f)
MCU
LED
Capacitance
Resistance
Twisting
Bending

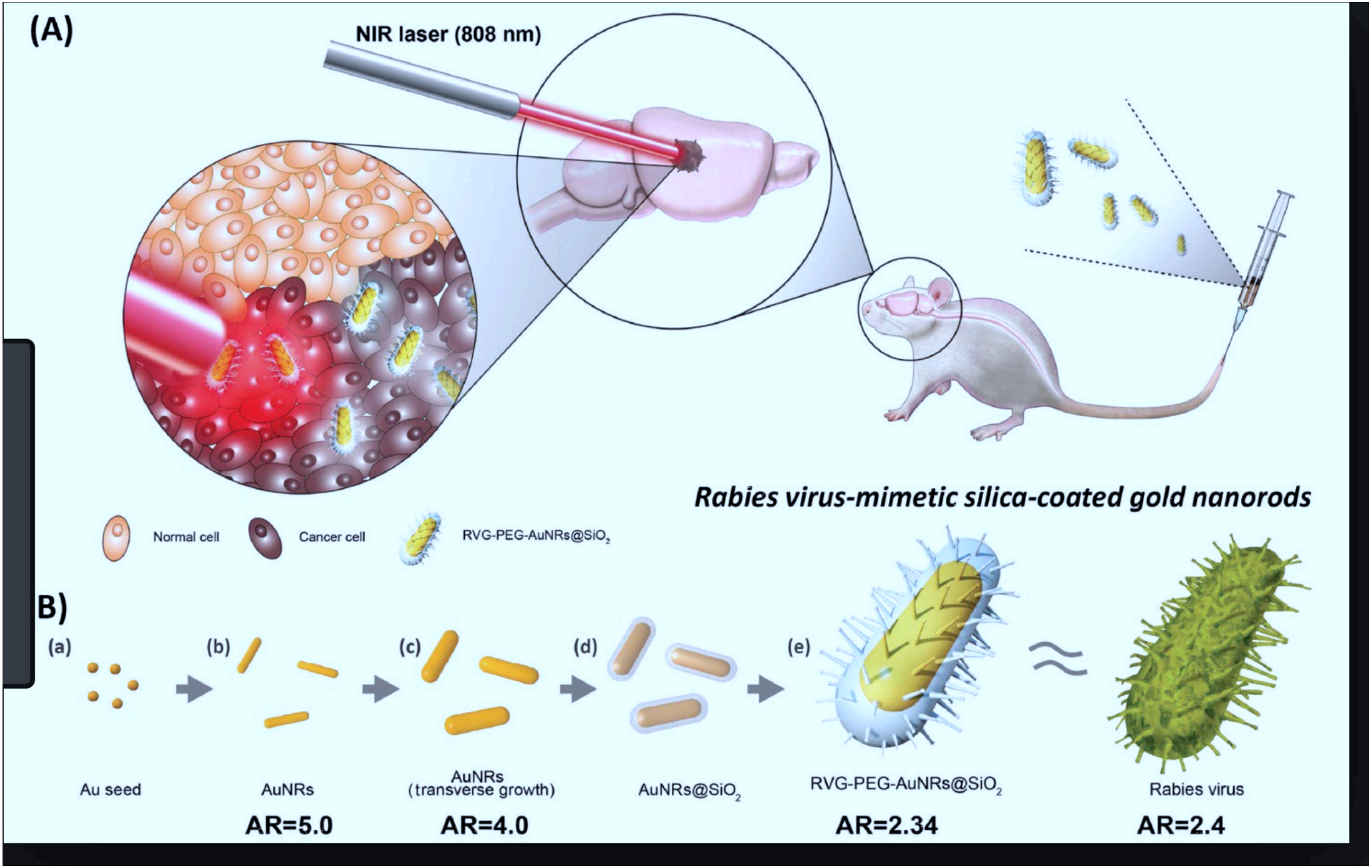


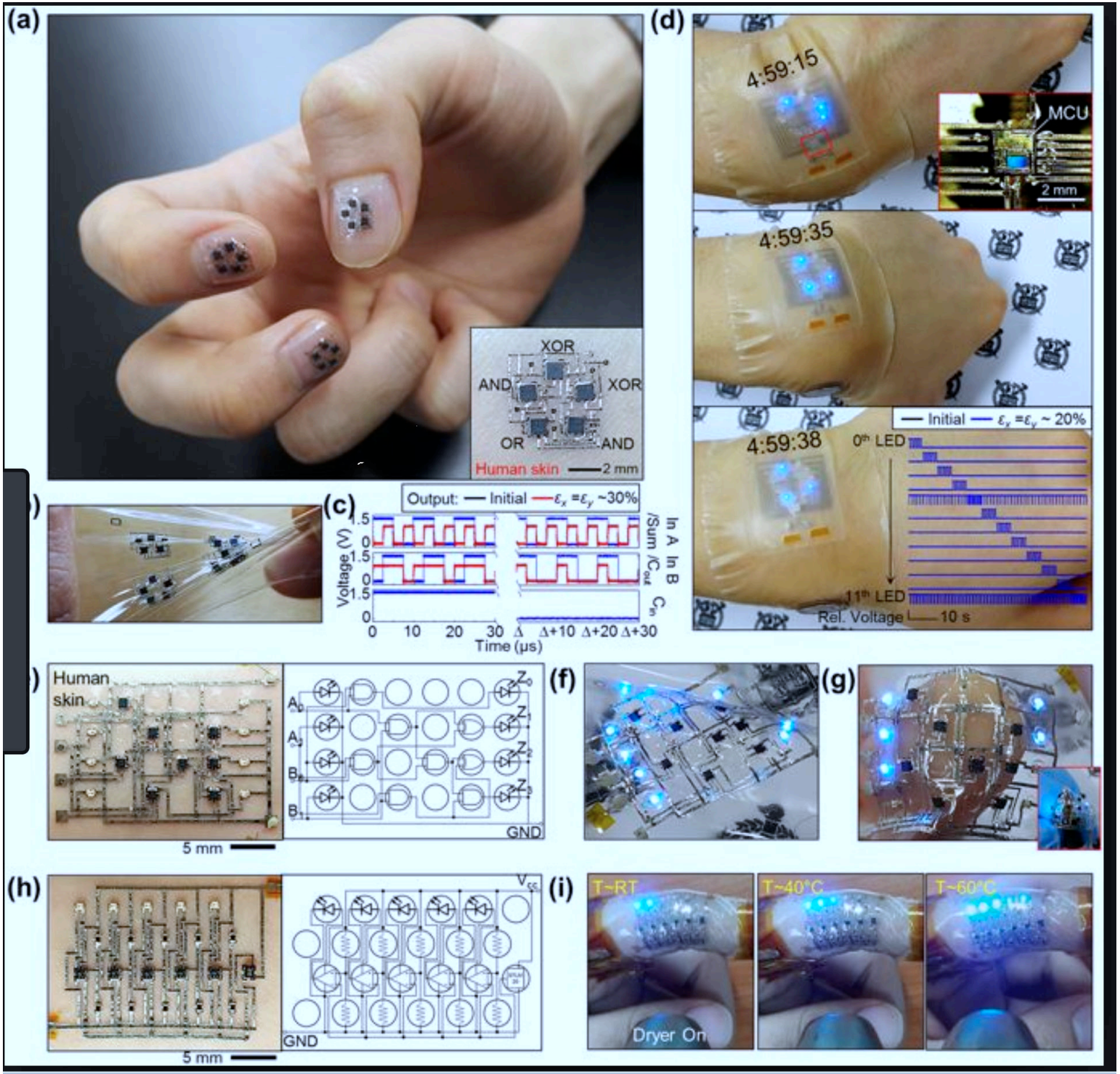
STRETCHABLE CIRCUITBOARD

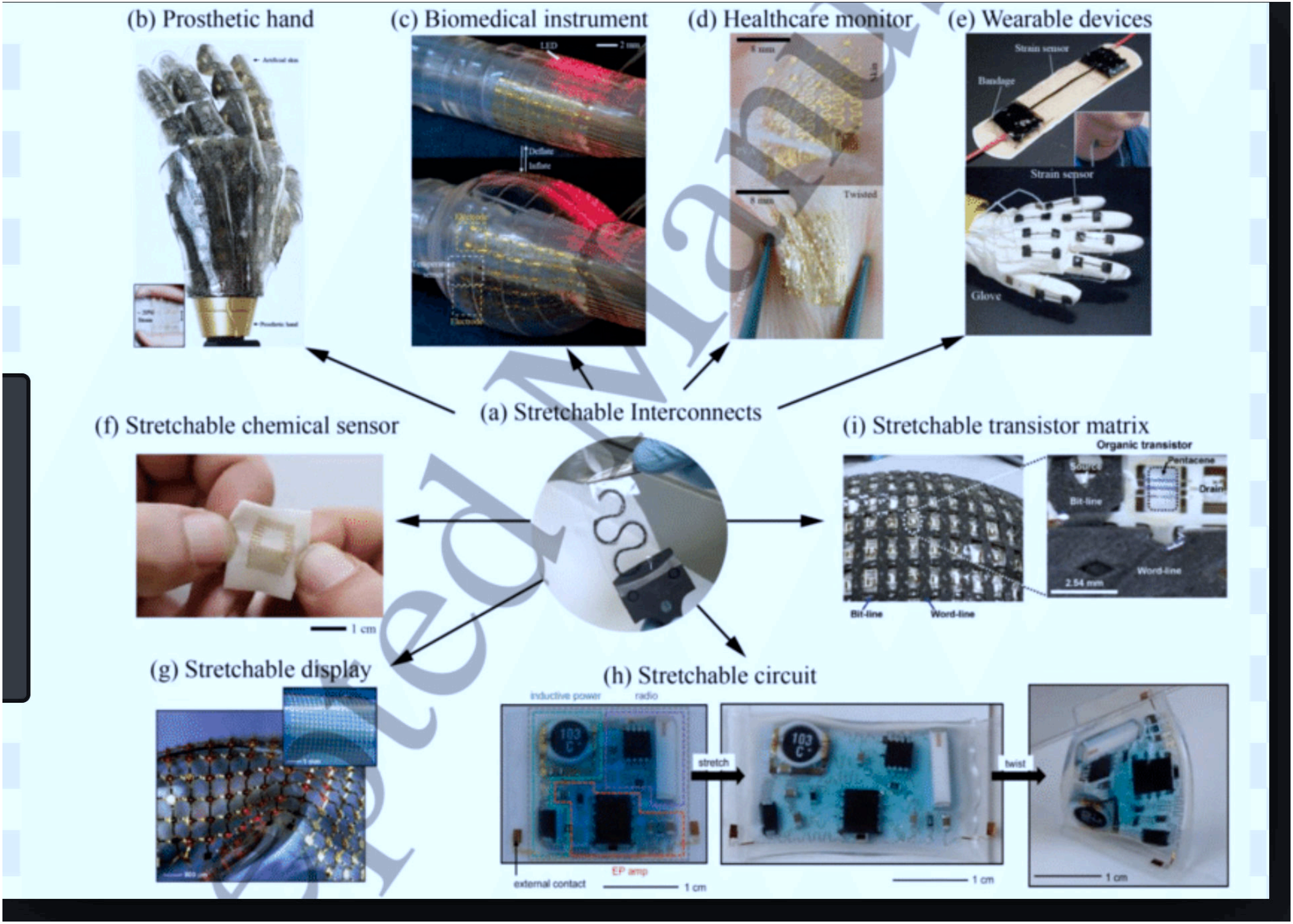

Stretchability gradient
Stiff PDMS
SM LED
Soft PDMS
Contact pad
Ag paste
Ag NWs/PDMS
Stretchable wiring
100%

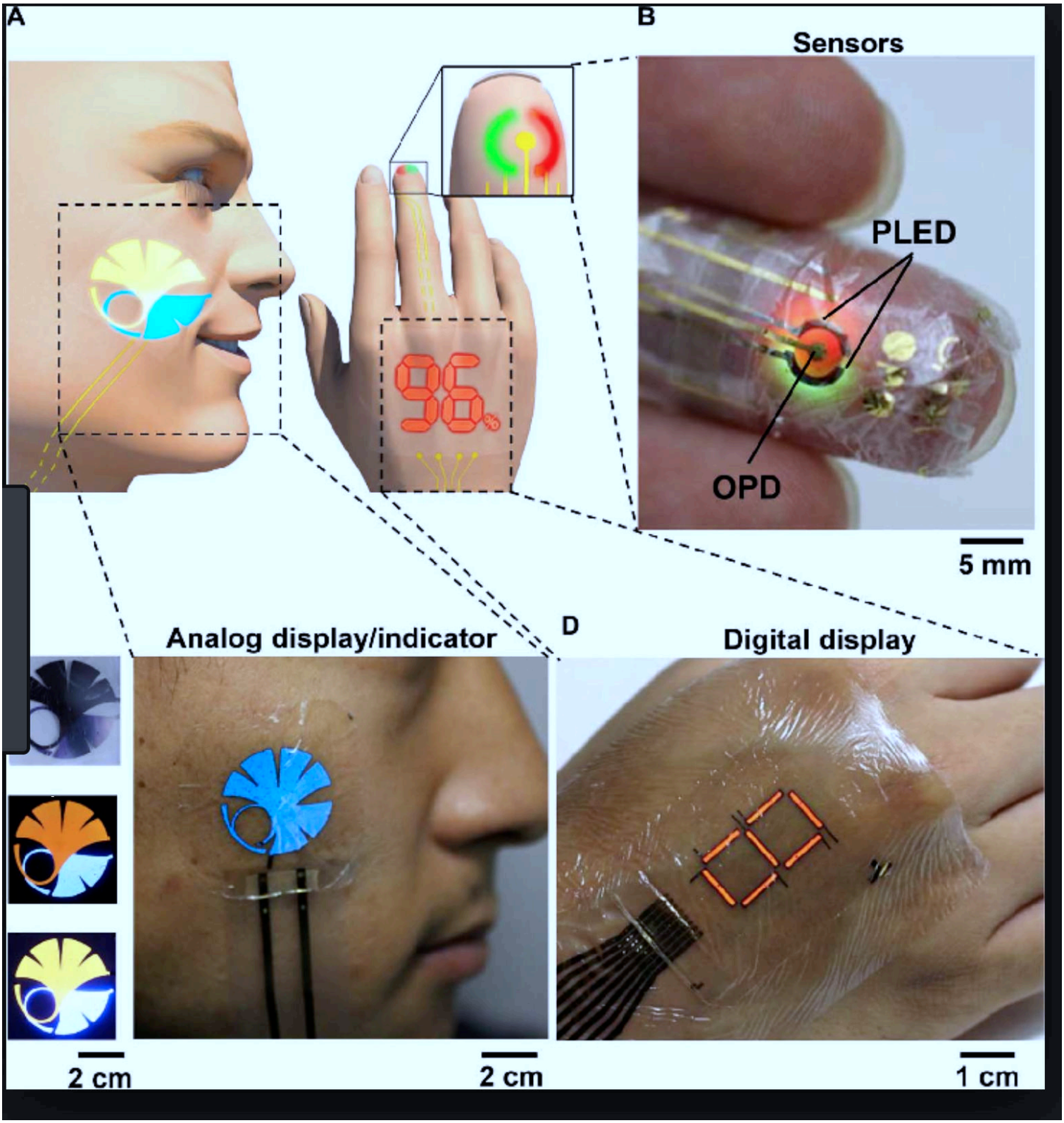

a
8 mm
Skin
PVA
10 mm
(°C)
°C
30
28
26
30.5
30.3
30.1
29.9
8 mm
Twisted
Tweezers
2 mm
(°C)
22.6
22.4
22.2
22.0
21.8
21.6
b
Wearing the device for 24hours, 2 times of shower included
The skin under the device after 24hours' wearing, highlighted by black ink
Water Droplet
Water Vapor
Air
Air
Water Vapor
Temperature /°C
Time /min
By mercury thermometer
By BCTS
c
Temperature (°C)
Averaged region
Areas
..11
..12
Avg 33.24
Min 32.80
Max 33.76
Sdv 0.23
eps 1.00
Before drinking hot water
Averaged region
Areas
..11
..12
Avg 34.22
Min 33.59
Max 34.87
Sdv 0.31
eps 1.00
After drinking hot water

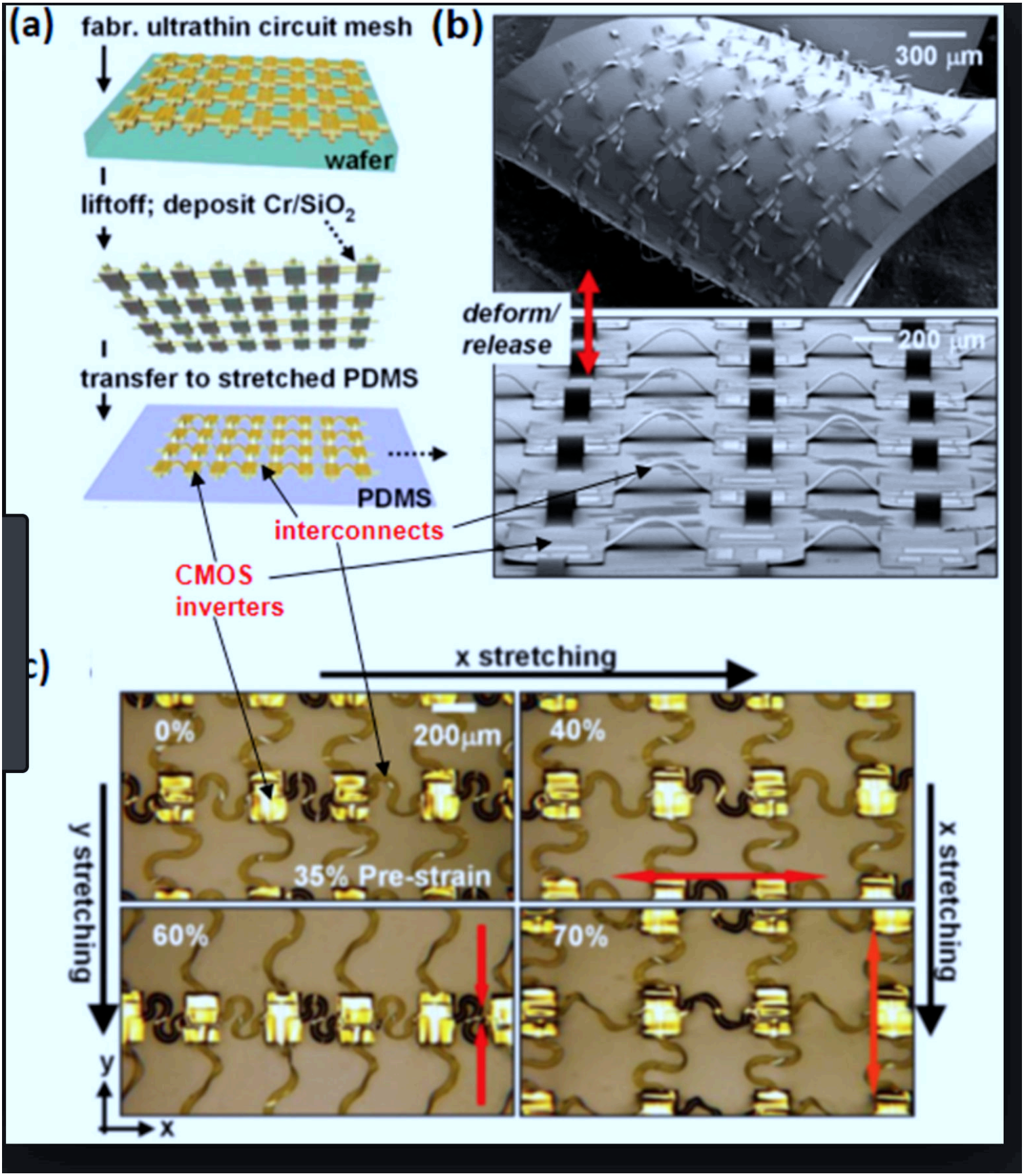

Hybrid delivery/therapeutic
neural interface
Recording
Biosensing
Stimulation
Multifunctional
flexible implant

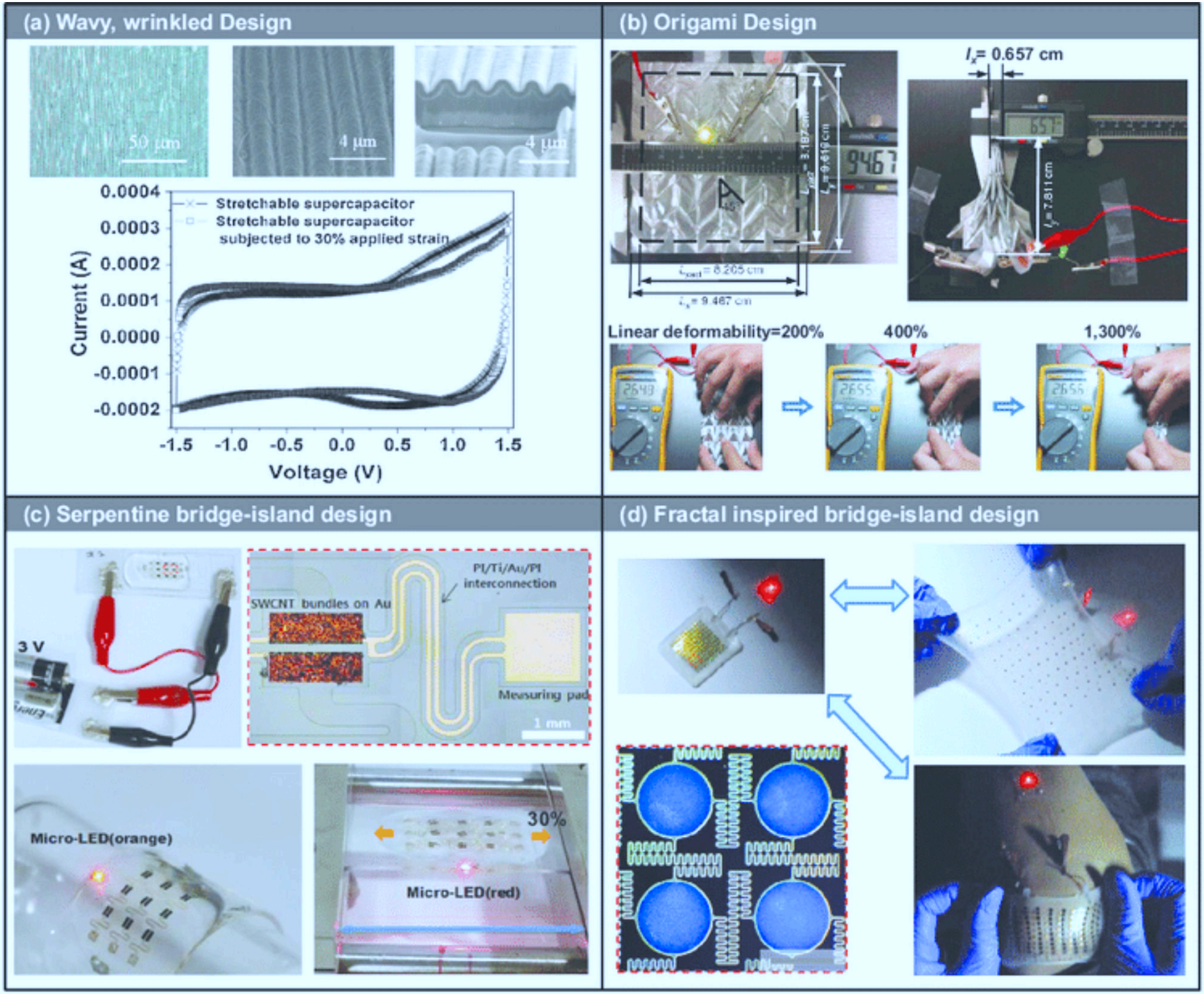

(A)
NIR laser (808 nm)
Rabies virus-mimetic silica-coated gold nanorods
Normal cell
Cancer cell
RVG-PEG-AuNRs@SiO2
B)
(a)
(b)
(c)
(d)
(e)
Au seed
AuNRs
AR=5.0
AuNRs
(transverse growth)
AR=4.0
AuNRs@SiO2
RVG-PEG-AuNRs@SiO2
AR=2.34
Rabies virus
AR=2.4

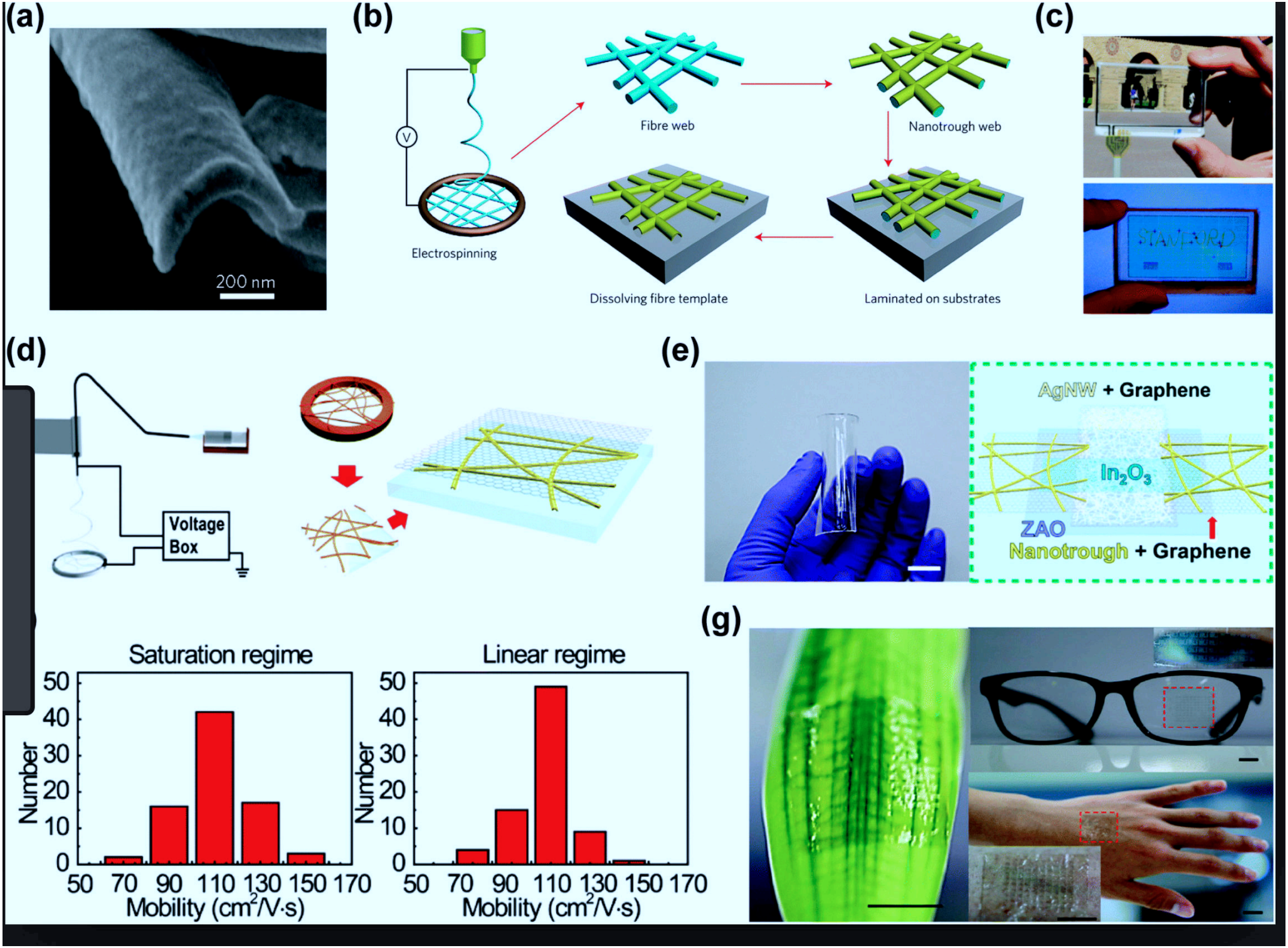

(a)
XOR
AND
XOR
OR
AND
Human skin
2 mm
(b)
(c)
Output: Initial $\varepsilon_x = \varepsilon_y$ ~30%
Voltage (V)
In A
In B
/Sum /C_{out}
C_{in}
0 10 20 30 Δ Δ+10 Δ+20 Δ+30
Time (μs)
(d)
4:59:15
MCU
2 mm
4:59:35
4:59:38
Initial $\varepsilon_x = \varepsilon_y$ ~ 20%
0th LED
11th LED
Rel. Voltage
10 s
(e)
Human skin
5 mm
GND
(f)
(g)
(h)
5 mm
GND
(i)
T~RT
Dryer On
T~40°C
T~60°C


(b) Prosthetic hand
(c) Biomedical instrument
(d) Healthcare monitor
(e) Wearable devices
Strain sensor
Bandage
Strain sensor
Glove
LED
2 mm
Deflate
Inflate
Twisted
(a) Stretchable Interconnects
(f) Stretchable chemical sensor
1 cm
(i) Stretchable transistor matrix
Organic transistor
Source
Pentacene
Drain
Bit-line
Word-line
2.54 mm
Bit-line
Word-line
(g) Stretchable display
(h) Stretchable circuit
inductive power
radio
EP amp
external contact
1 cm
stretch
1 cm
twist
1 cm

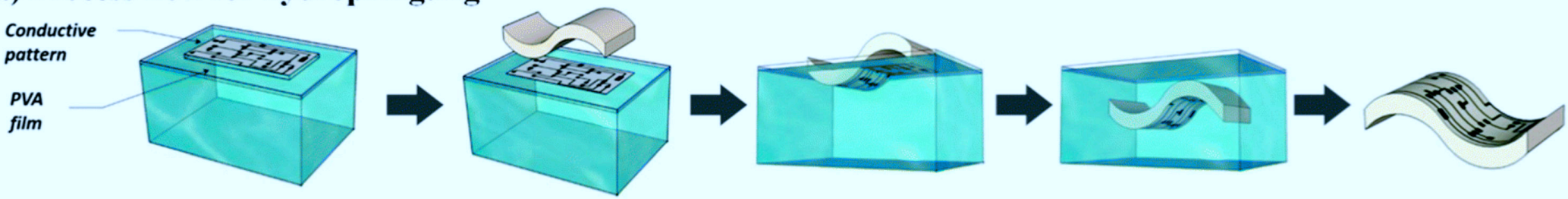

A
B
Sensors
PLED
OPD
5 mm
96%
D
Analog display/indicator
Digital display
2 cm
2 cm
1 cm


(a)
fabr. ultrathin circuit mesh
wafer
liftoff; deposit Cr/SiO2
transfer to stretched PDMS
PDMS
interconnects
CMOS
inverters
(b)
300 μm
deform/
release
200 μm
c)
x stretching
0%
200μm
35% Pre-strain
40%
y stretching
x stretching
60%
70%
y
x


(a) Wavy, wrinkled Design
50 μm
4 μm
4 μm
Stretchable supercapacitor
Stretchable supercapacitor subjected to 30% applied strain
Current (A)
Voltage (V)
(b) Origami Design
l_x= 0.657 cm
Linear deformability=200%
400%
1,300%
(c) Serpentine bridge-island design
3 V
PI/Ti/Au/PI interconnection
SWCNT bundles on Au
Measuring pad
1 mm
Micro-LED(orange)
30%
Micro-LED(red)
(d) Fractal inspired bridge-island design

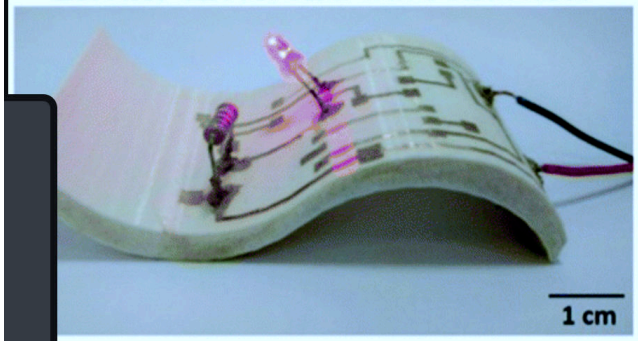

(a)
200 nm
(b)
V
Electrospinning
Fibre web
Nanotrough web
Dissolving fibre template
Laminated on substrates
(c)
STANFORD
(d)
Voltage Box
Saturation regime
Linear regime
Number
Mobility (cm²/V·s)
0
10
20
30
40
50
50 70 90 110 130 150 170
(e)
AgNW + Graphene
In2O3
ZAO
Nanotrough + Graphene
(g)

(a) Process flow for hydropringting

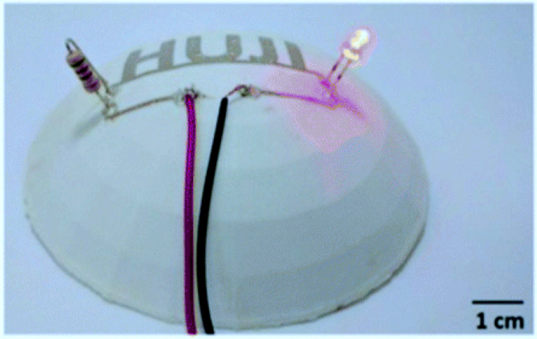


(b) Electric circuit on curve surface

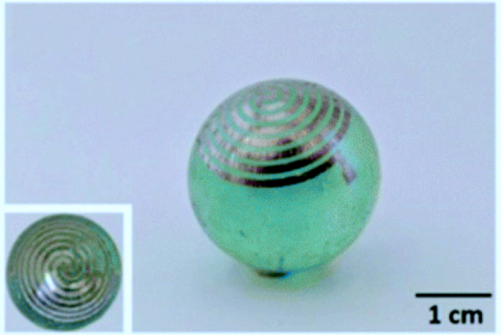
Electric circuit on a wave structures

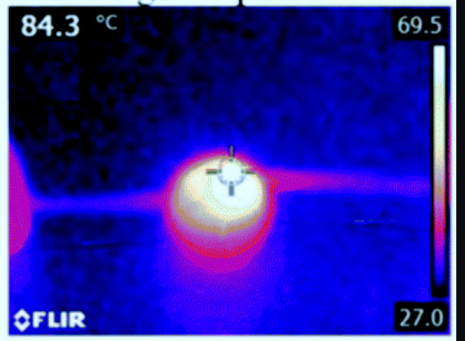


Electric circuit on a dome structure



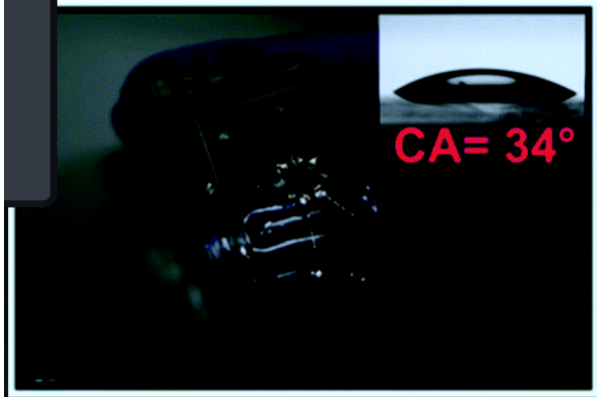
Heater device transferred onto a glass sphere



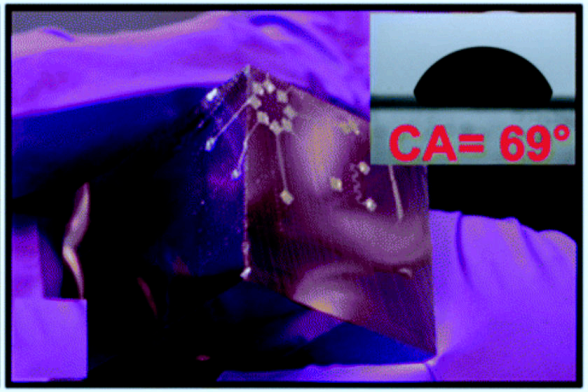


) Patterns on various surfaces

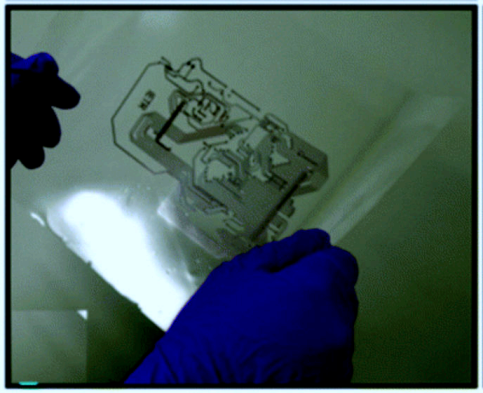
Glass beaker



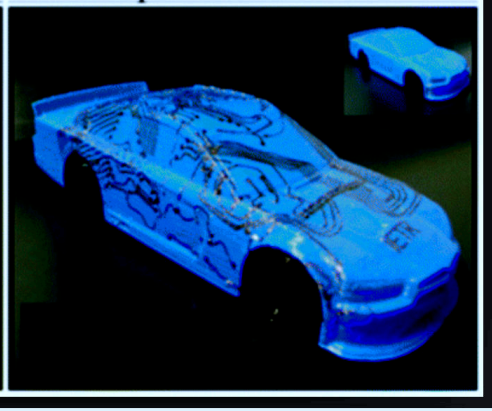
PMMA cube

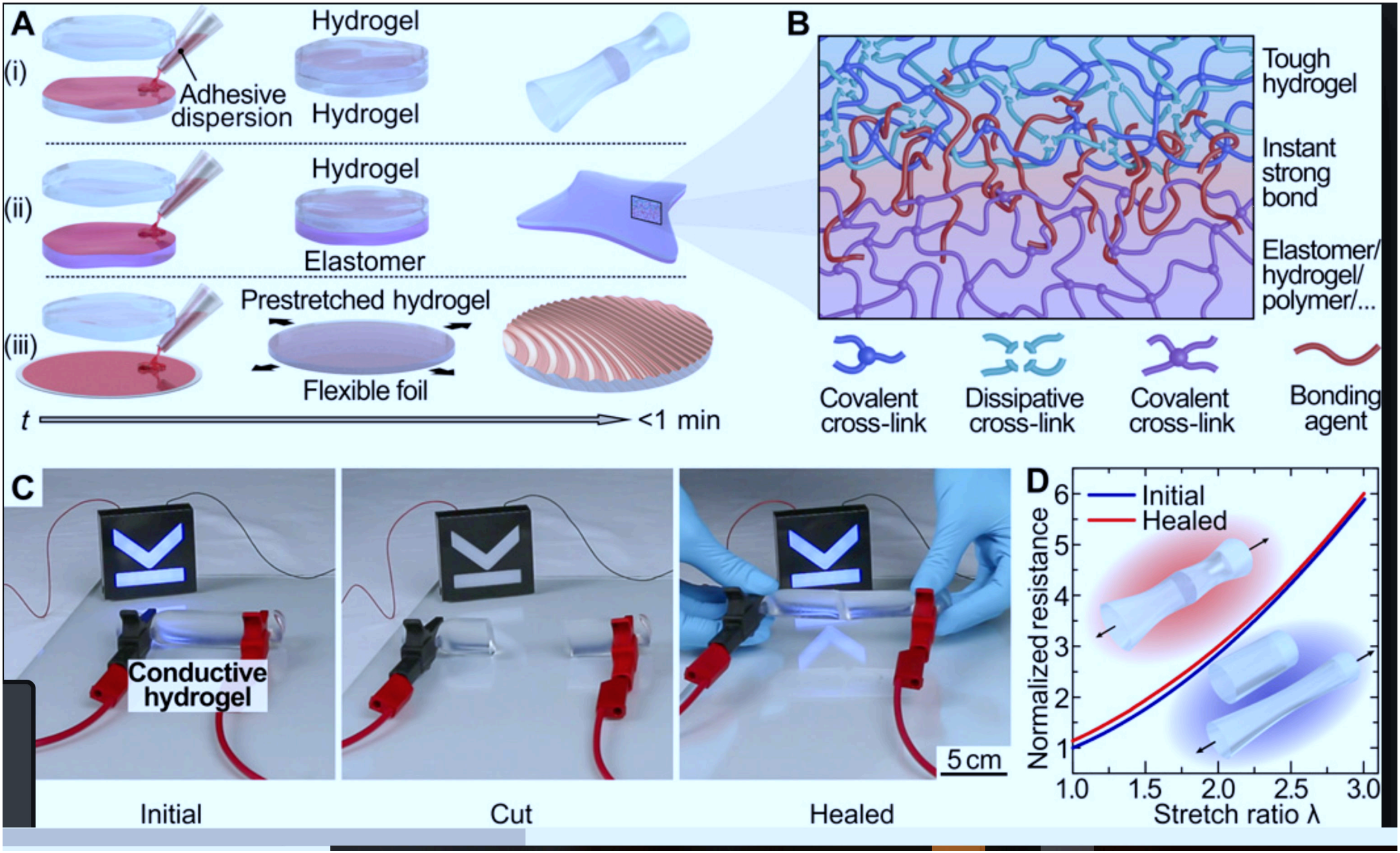


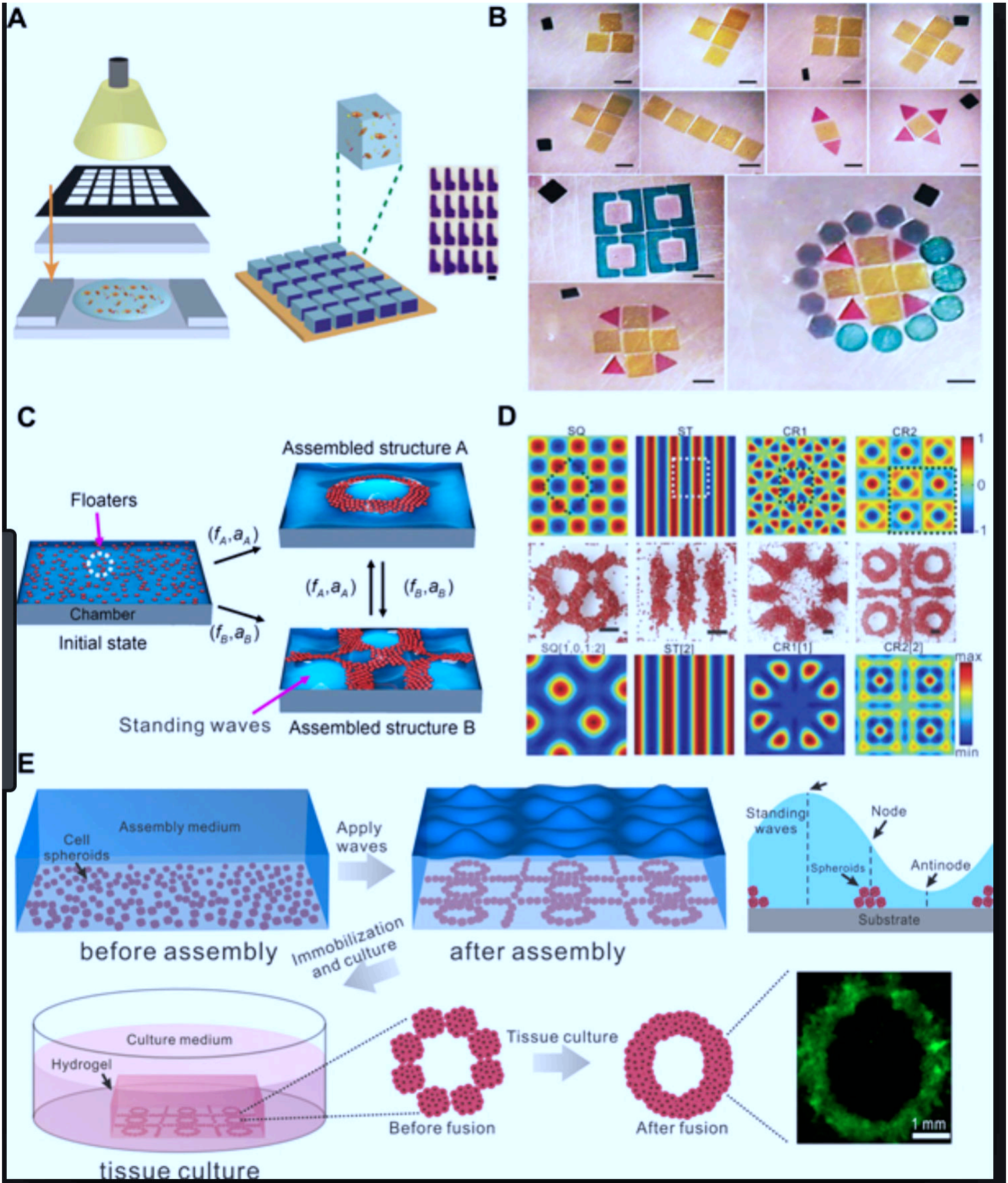
A4 size PVA substrate



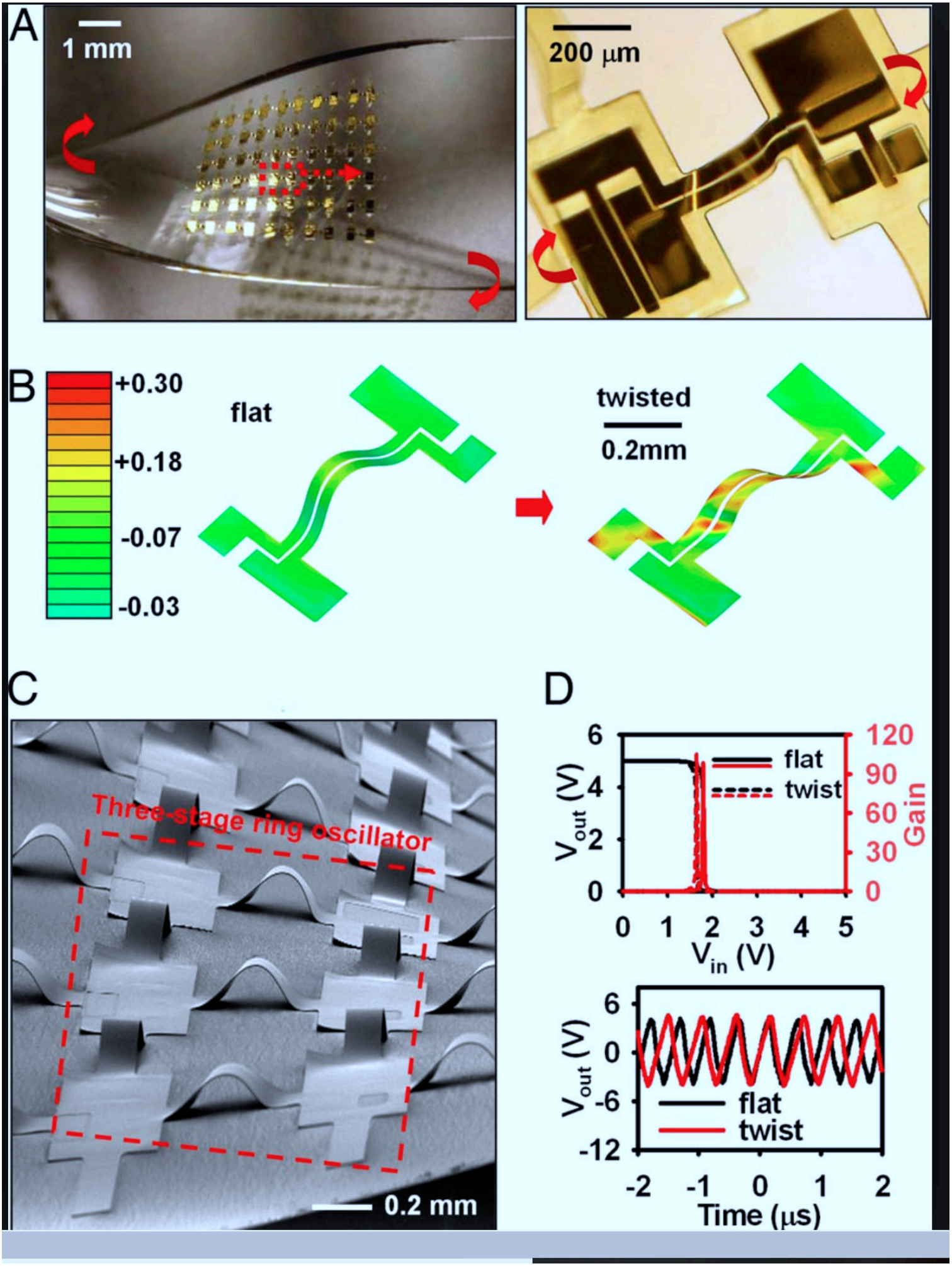
3D printed model car

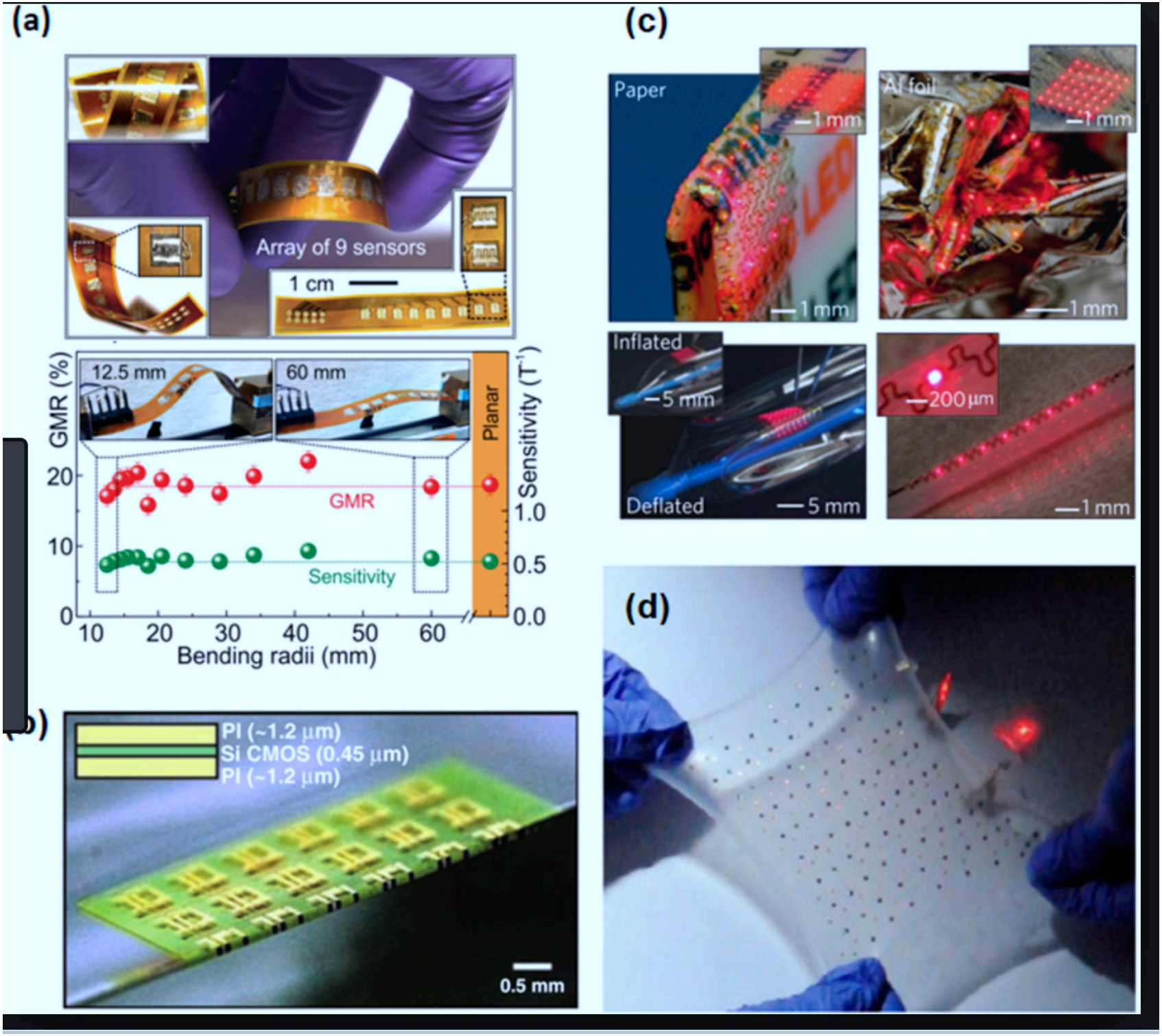


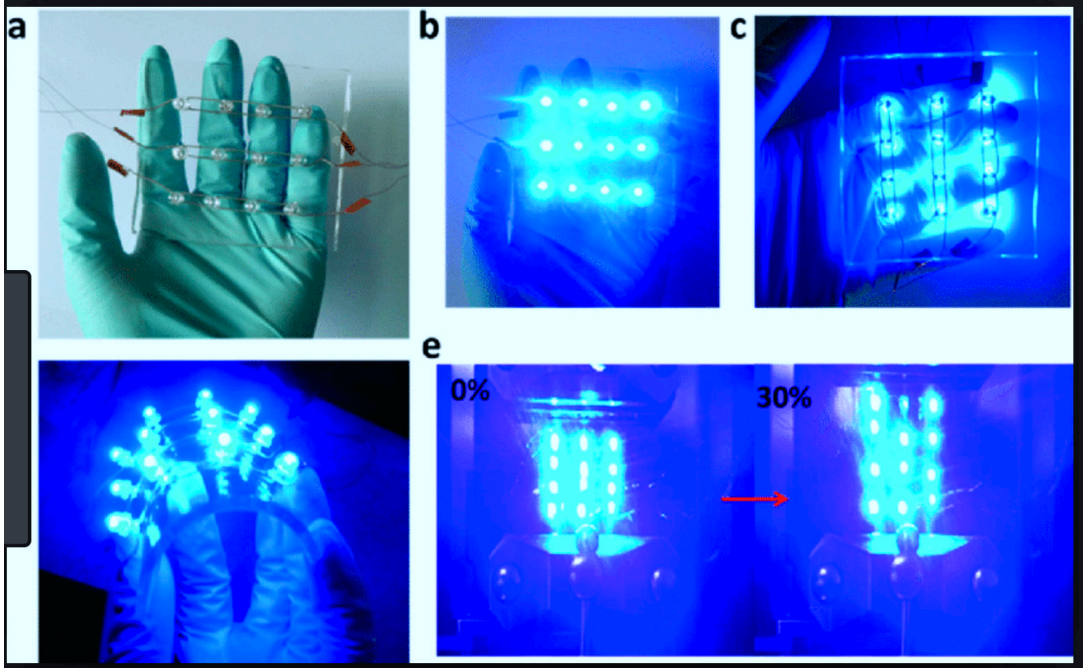

A
(i)
Adhesive dispersion
Hydrogel
Hydrogel
(ii)
Hydrogel
Elastomer
(iii)
Prestretched hydrogel
Flexible foil
t
<1 min
B
Tough hydrogel
Instant strong bond
Elastomer/ hydrogel/ polymer/...
Covalent cross-link
Dissipative cross-link
Covalent cross-link
Bonding agent
C
Conductive hydrogel
5 cm
Initial
Cut
Healed
D
Initial
Healed
Normalized resistance
Stretch ratio λ
1.0
1.5
2.0
2.5
3.0
1
2
3
4
5
6



ARTIFICIAL TISSUE MODELING


A
1 mm
200 μm
B
+0.30
+0.18
-0.07
-0.03
flat
twisted
0.2mm
C
Three-stage ring oscillator
0.2 mm
D
6
4
2
0
V_{out} (V)
120
90
60
30
0
Gain
flat
twist
0 1 2 3 4 5
V_{in} (V)
6
0
-6
-12
V_{out} (V)
flat
twist
-2 -1 0 1 2
Time (μs)


(a)
Array of 9 sensors
1 cm
12.5 mm
60 mm
GMR (%)
Sensitivity (T⁻¹)
GMR
Sensitivity
Planar
Bending radii (mm)
(b)
PI (~1.2 μm)
Si CMOS (0.45 μm)
PI (~1.2 μm)
0.5 mm
(c)
Paper
Al foil
1 mm
Inflated
5 mm
Deflated
200 μm
(d)



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Transparent, bendable, and stretchable LED arra
AgNW-PDMS in the electric circuitry. (a) Integra
transparent and stretchable ...

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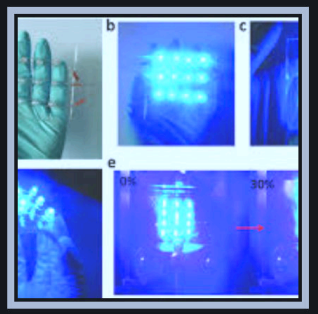
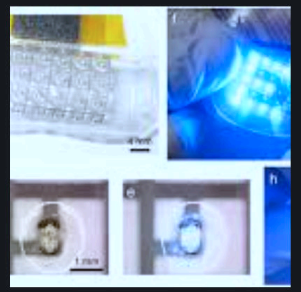
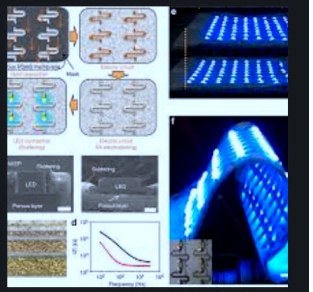
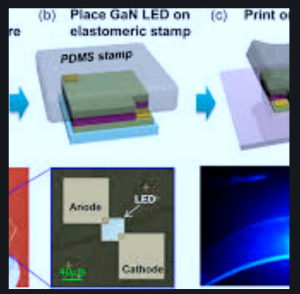
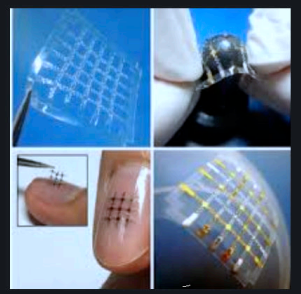
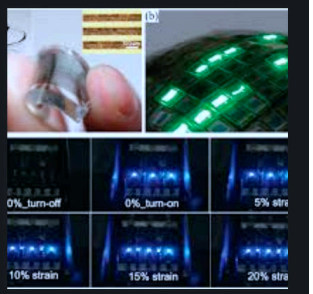
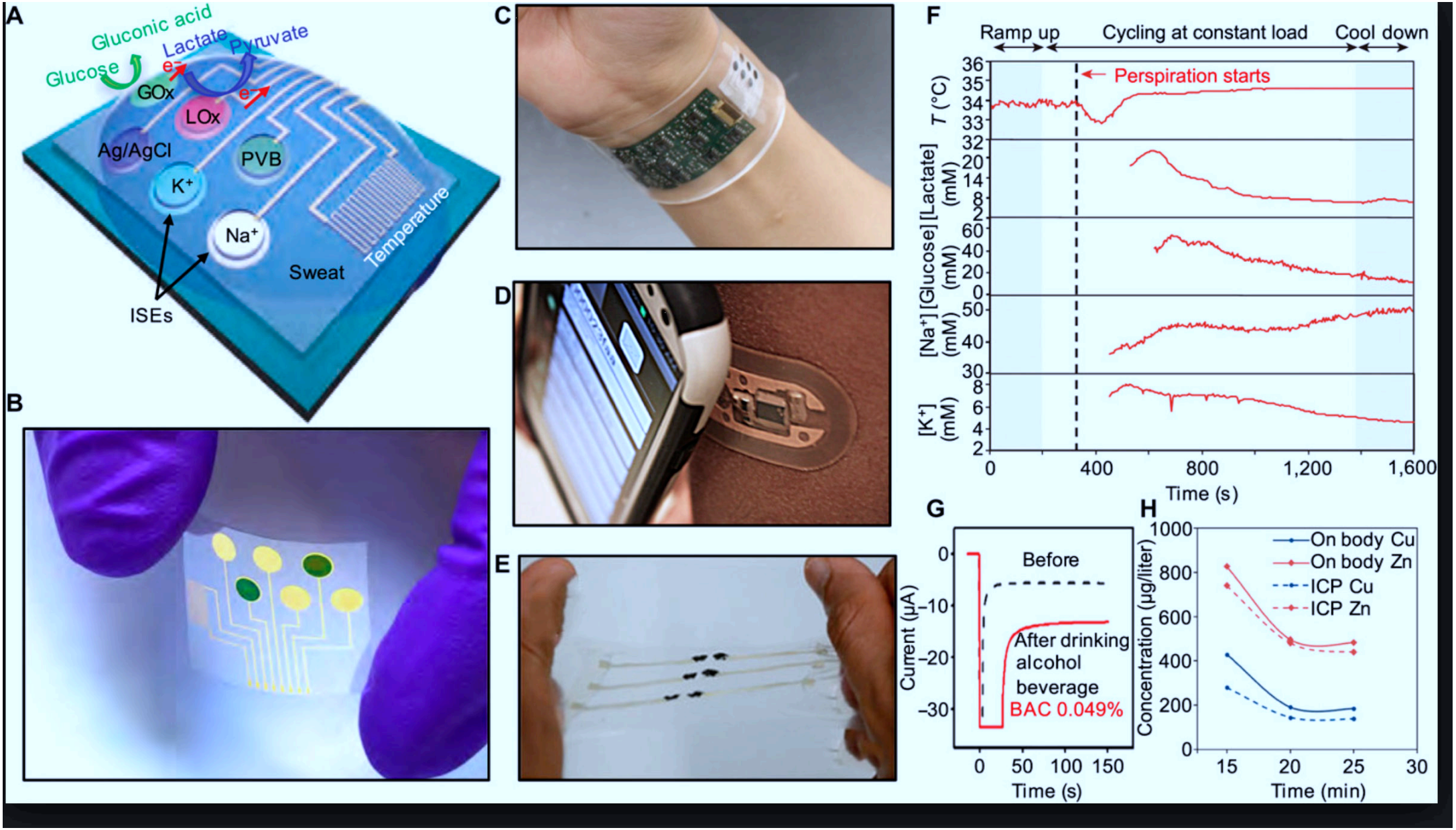
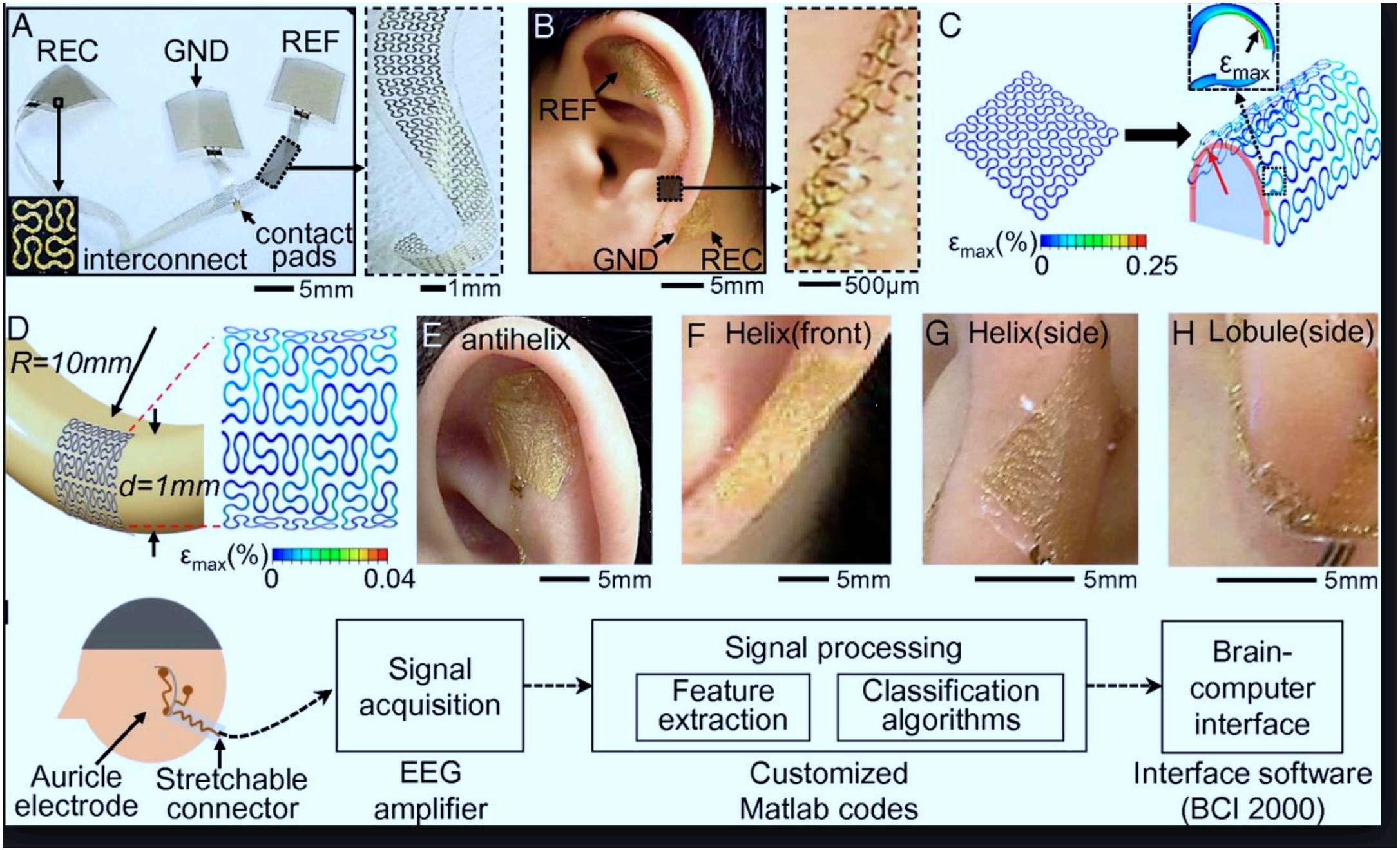






A
Gluconic acid
Glucose
Lactate
Pyruvate
e⁻
GOx
LOx
e⁻
Ag/AgCl
PVB
K⁺
Na⁺
Sweat
Temperature
ISEs
B
C
D
E
F
Ramp up
Cycling at constant load
Cool down
Perspiration starts
T (°C)
[Lactate] (mM)
[Glucose] (mM)
[Na⁺] (mM)
[K⁺] (mM)
Time (s)
G
Before
After drinking alcohol beverage
BAC 0.049%
Current (μA)
Time (s)
H
On body Cu
On body Zn
ICP Cu
ICP Zn
Concentration (μg/liter)
Time (min)


A
REC
GND
REF
interconnect
contact pads
5mm
1mm
B
REF
GND
REC
5mm
500μm
C
ε_{max}
ε_{max}(%)
0
0.25
D
R=10mm
d=1mm
ε_{max}(%)
0
0.04
E antihelix
5mm
F Helix(front)
5mm
G Helix(side)
5mm
H Lobule(side)
5mm
Auricle electrode
Stretchable connector
Signal acquisition
EEG amplifier
Signal processing
Feature extraction
Classification algorithms
Customized Matlab codes
Brain-computer interface
Interface software (BCI 2000)

Please click here to view a larger version of this figure.

5. Using the rat head picture acquired in 1.3.5. co-register the positions of the 3 landmarks (R1, R2, and R3) in the MR points of the landmarks as references to generate the electrode positions as the electrodes are fixed on the scaffold

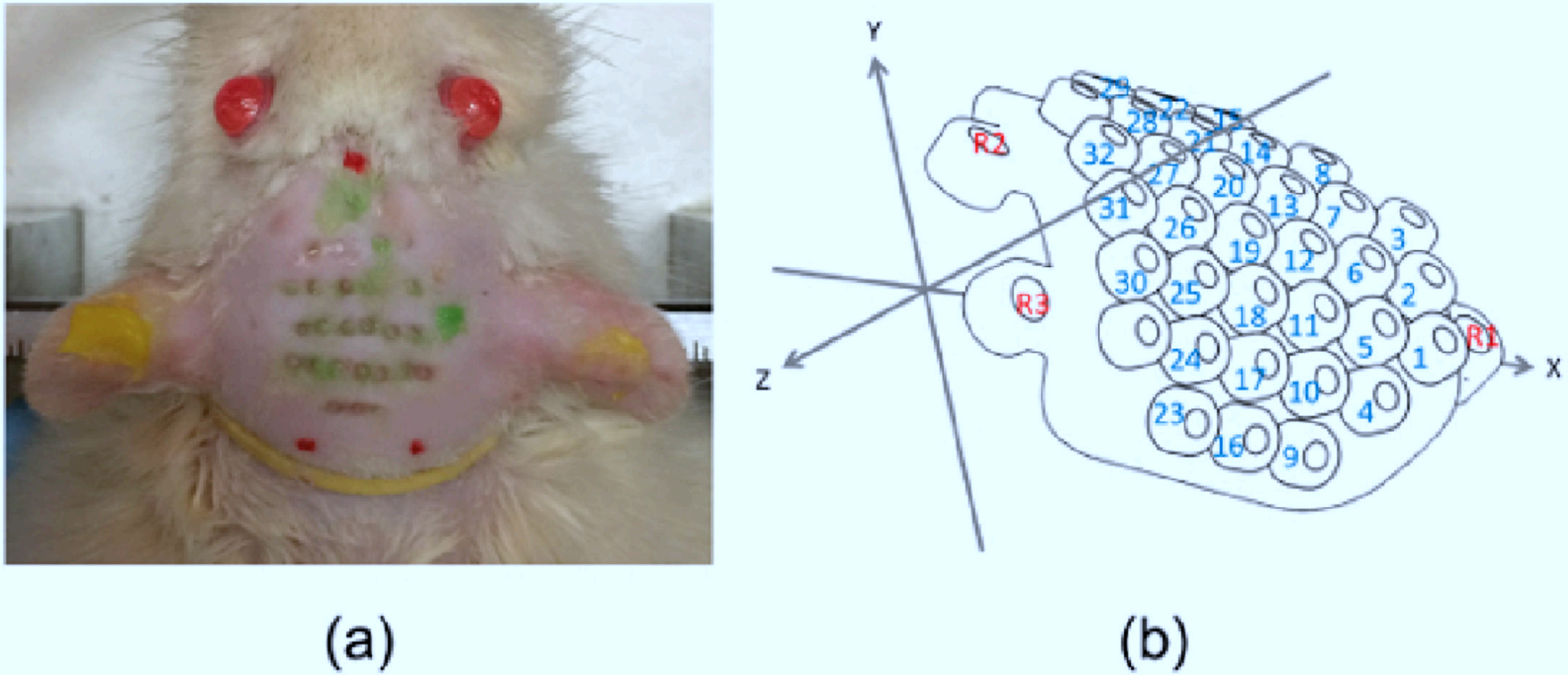
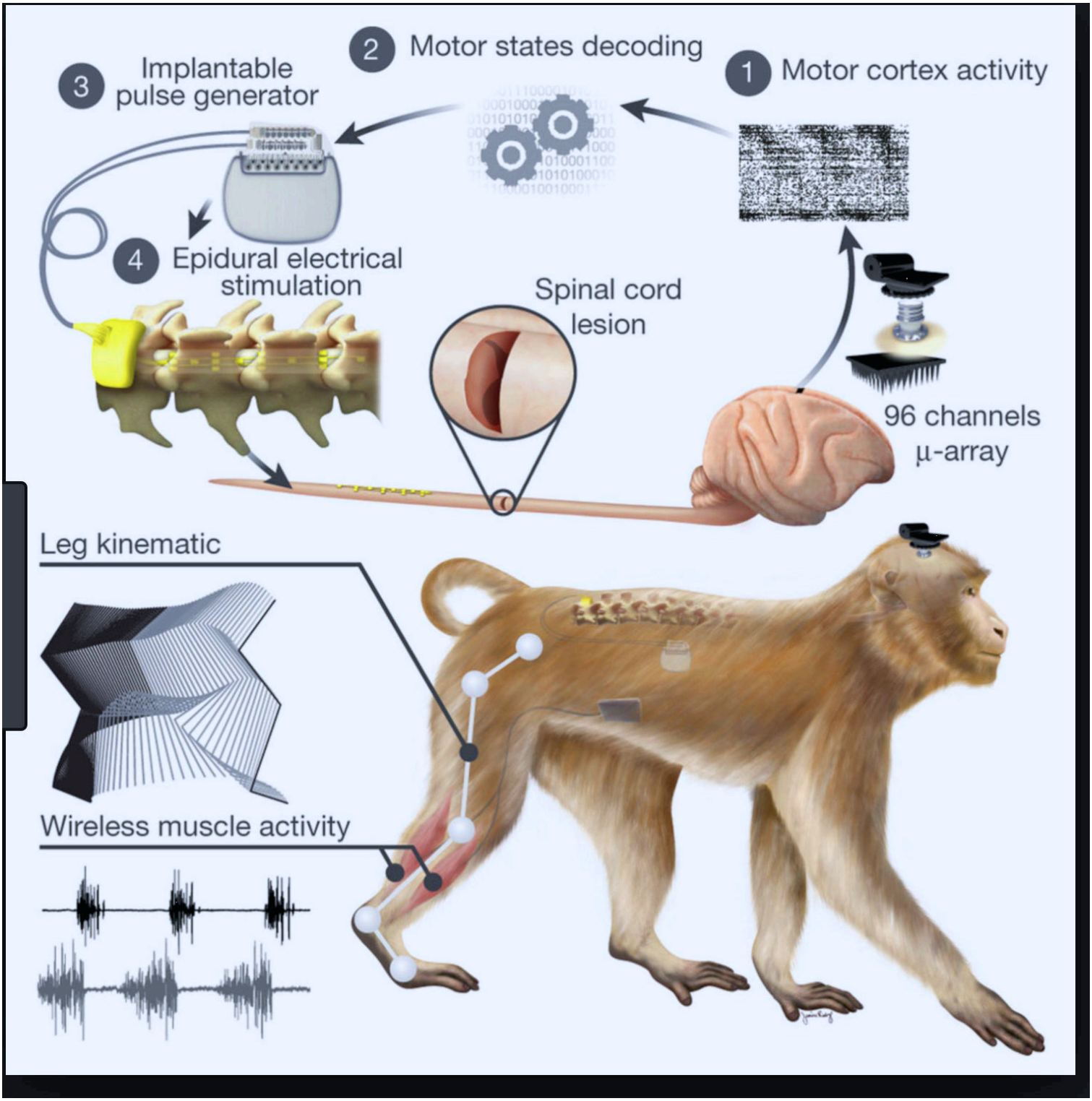
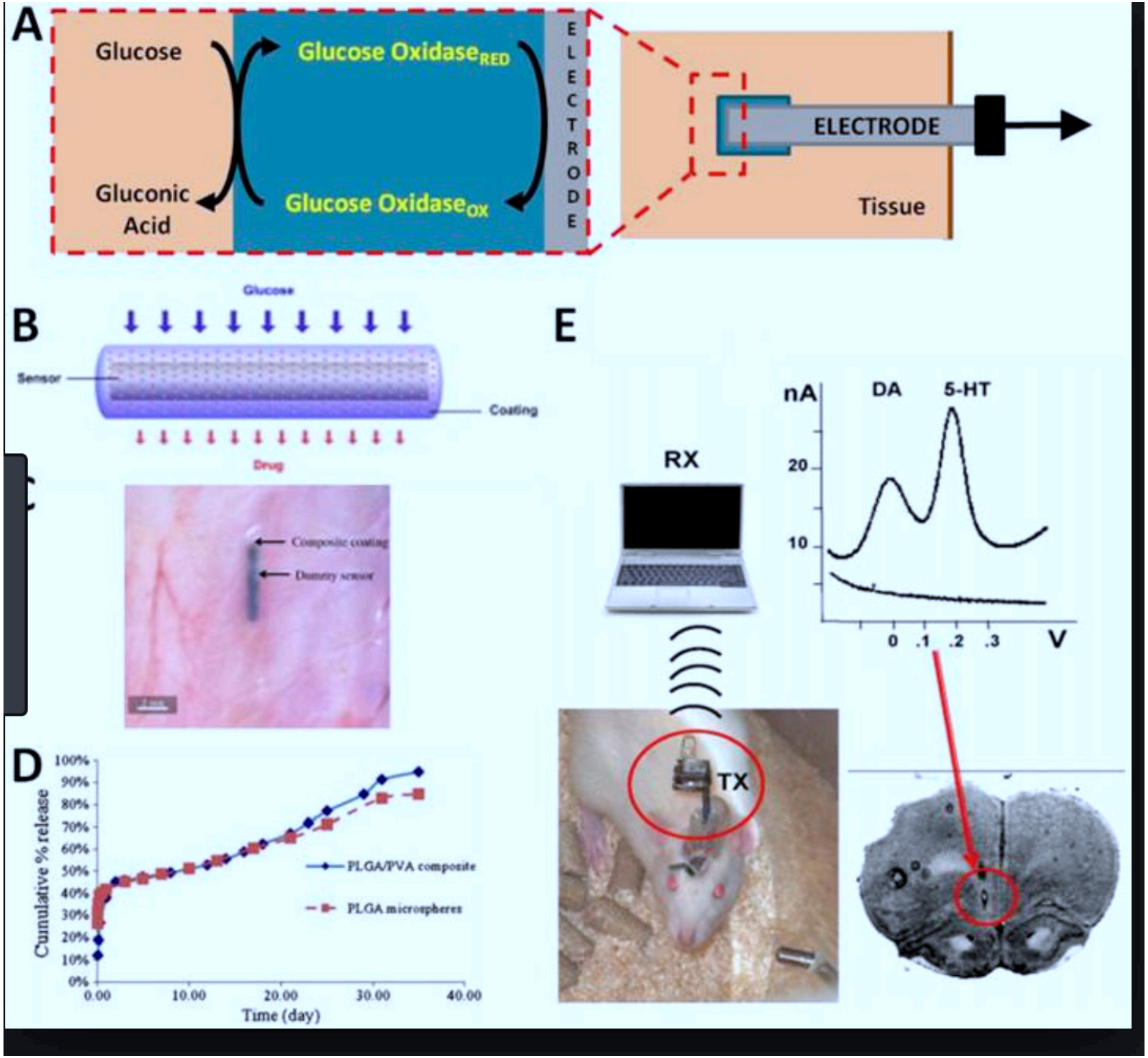
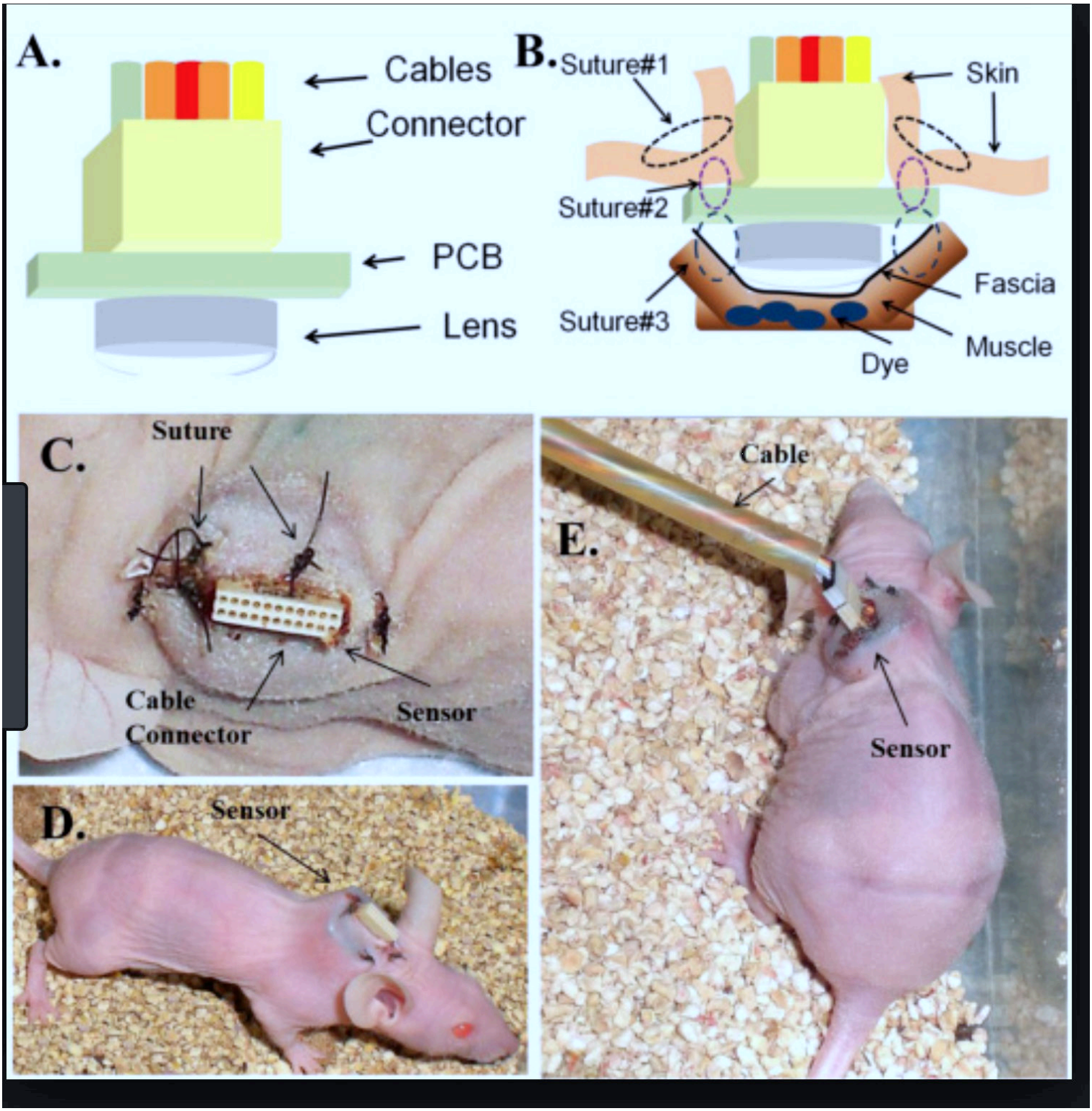


Figure 3. (A) Rat head picture used to obtain electrode positions and (b) the EEG mini-cap diagram with the coordin

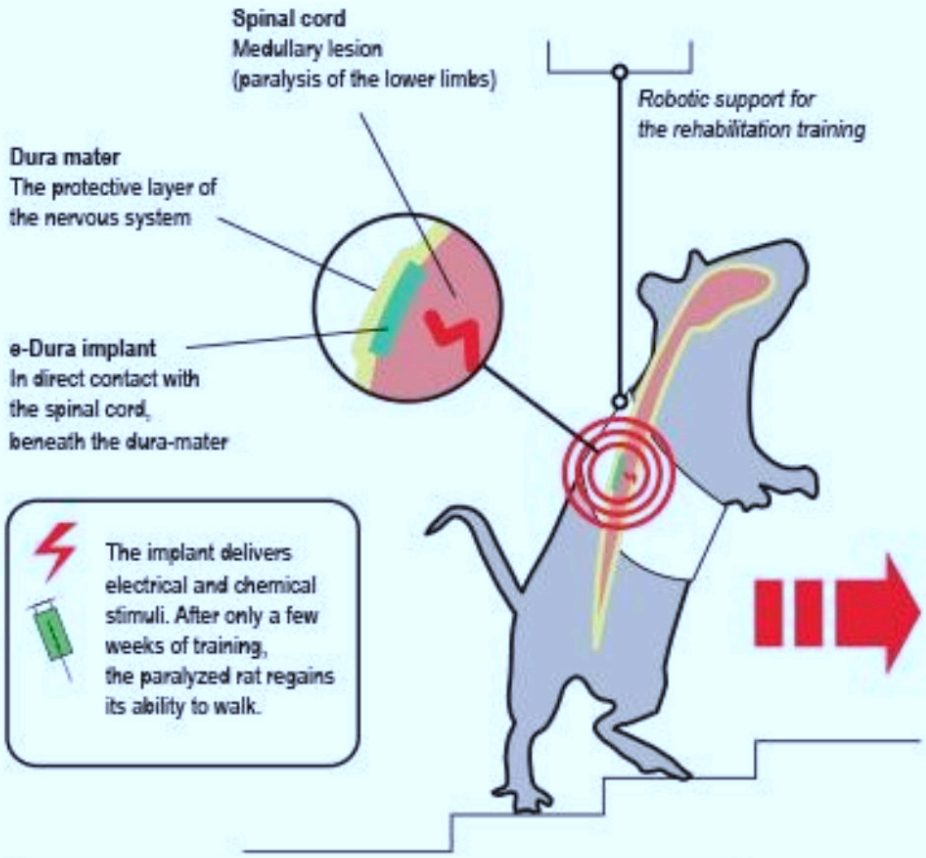

2 Motor states decoding
1 Motor cortex activity
3 Implantable pulse generator
4 Epidural electrical stimulation
Spinal cord lesion
96 channels μ-array
Leg kinematic
Wireless muscle activity


A
Glucose
Gluconic Acid
Glucose Oxidase$_{RED}$
Glucose Oxidase$_{OX}$
ELECTRODE
ELECTRODE
Tissue
B
Glucose
Sensor
Coating
Drug
C
Composite coating
Dummy sensor
D
Cumulative % release
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
10.00
20.00
30.00
40.00
Time (day)
PLGA/PVA composite
PLGA microspheres
E
RX
nA
DA
5-HT
20
10
0
.1
.2
.3
V
TX


A.
Cables
Connector
PCB
Lens
B.
Suture#1
Skin
Suture#2
Fascia
Suture#3
Muscle
Dye
C.
Suture
Cable
Connector
Sensor
D.
Sensor
E.
Cable
Sensor

The spinal cord implant that mimics living nervous tissue

The EPFL e-Dura implant has been successfully tested on paralyzed rats, allowing them to walk again. The flexible and stretchable device can be applied directly to the spinal cord without causing friction and damage, paving the way for future human trials.


Spinal cord
Medullary lesion
(paralysis of the lower limbs)
Robotic support for the rehabilitation training
Dura mater
The protective layer of the nervous system
e-Dura implant
In direct contact with the spinal cord, beneath the dura-mater
The implant delivers electrical and chemical stimuli. After only a few weeks of training, the paralyzed rat regains its ability to walk.

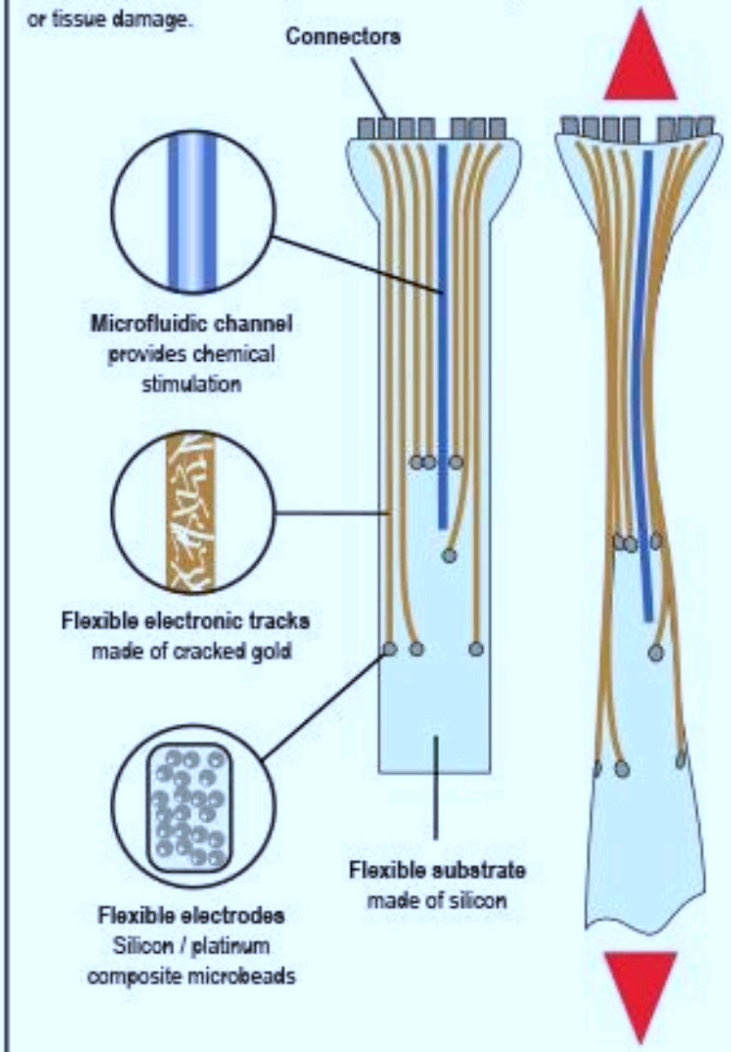
Two months post-implantation on lab rats

e-Dura implant:
The spinal cord presents no visible damage.

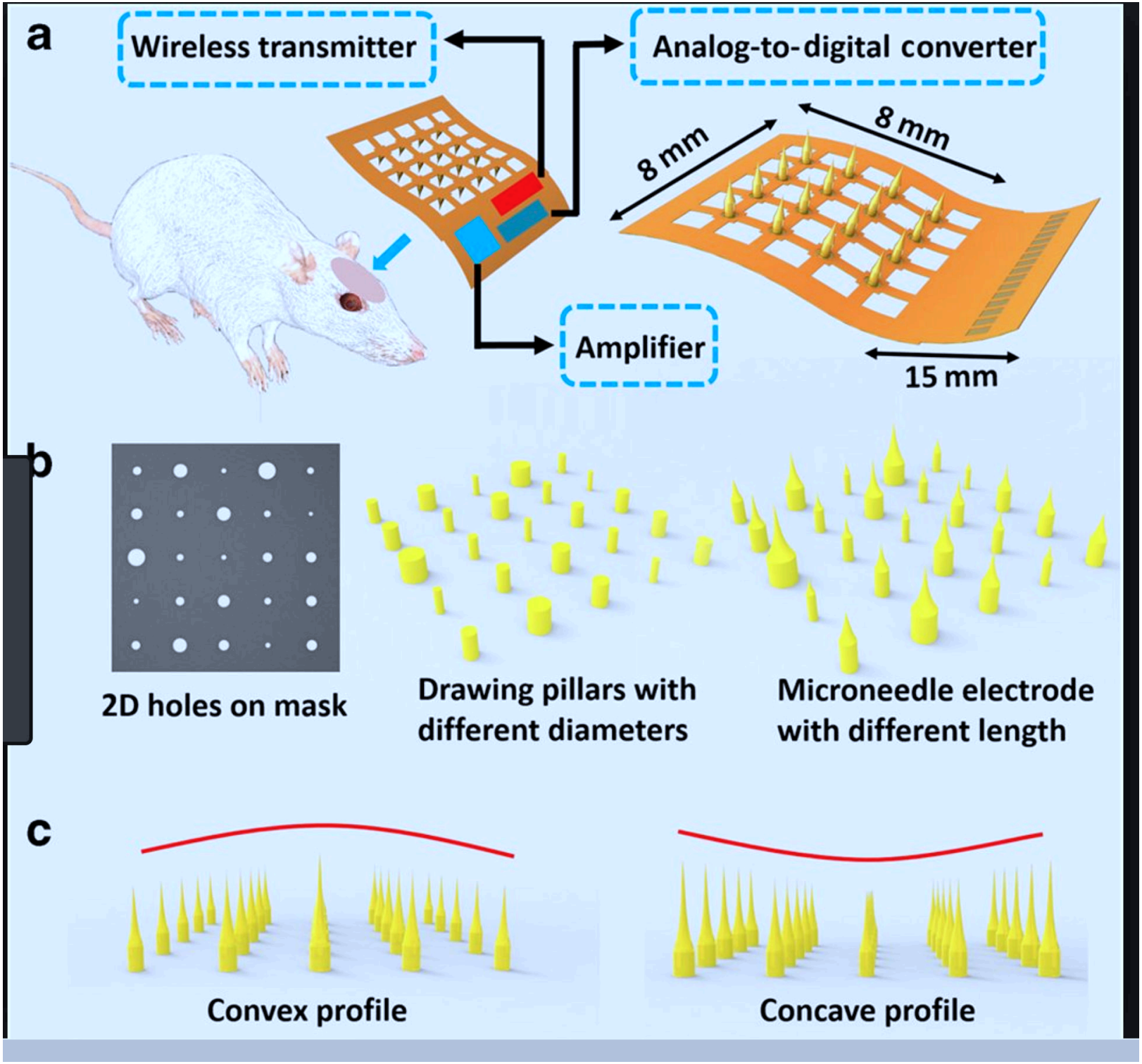
Conventional implants:
The spinal cord is severely damaged and its function is impaired.

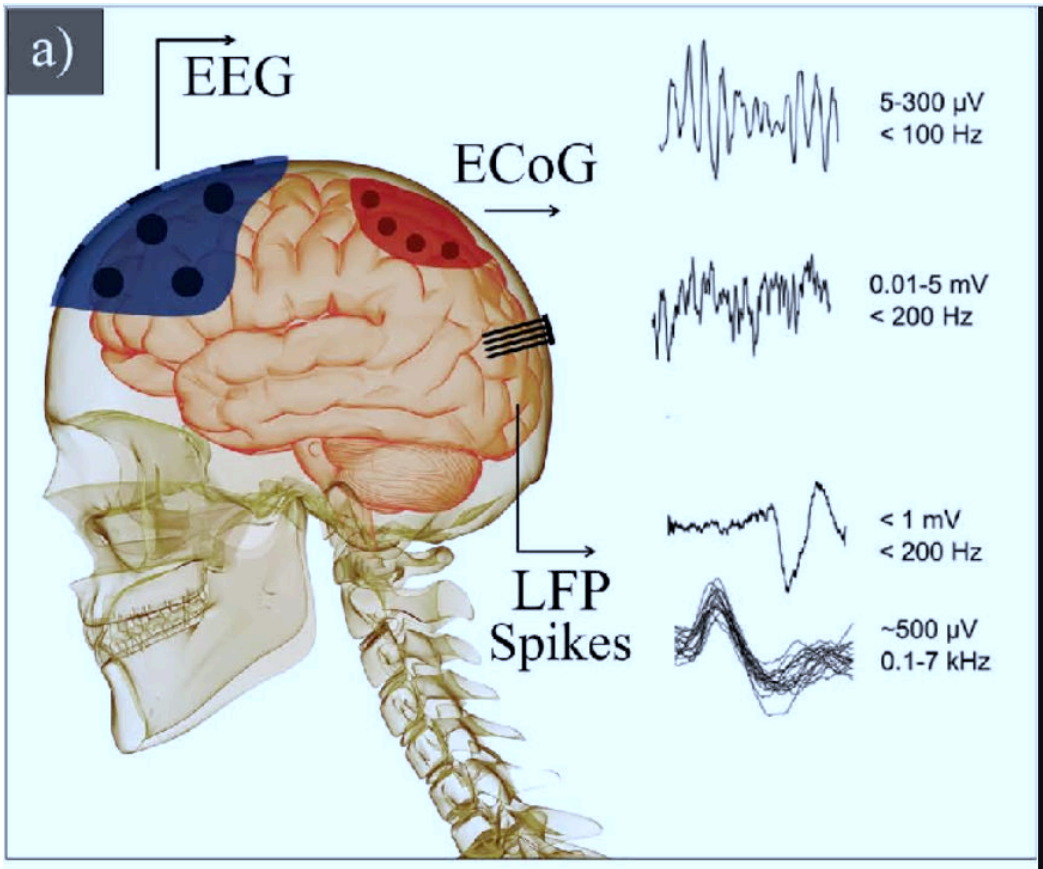
A feat of engineering: flexible, stretchable, and full of technology

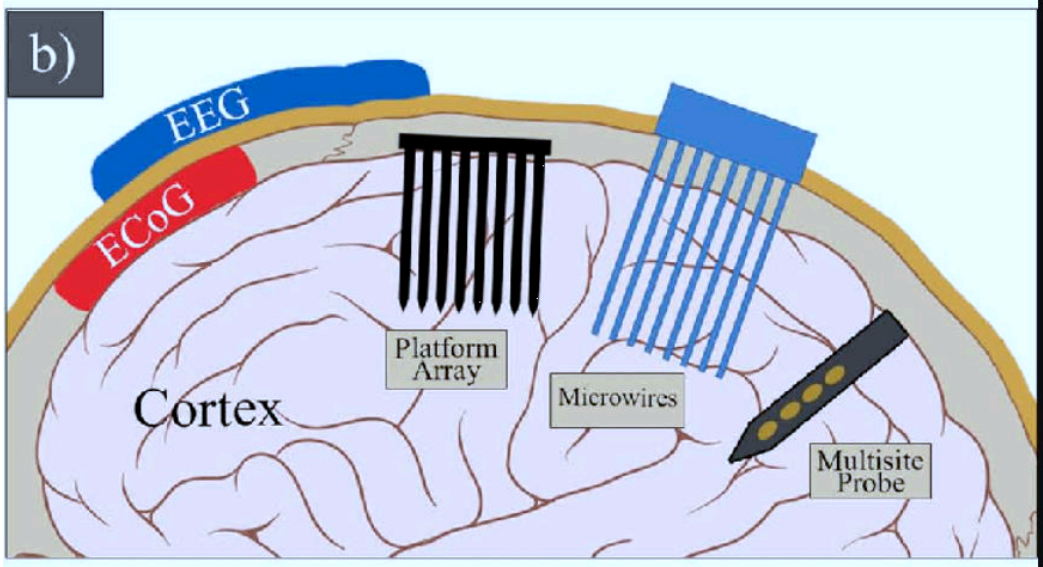
It took the researchers years to develop the e-Dura implant. Designed to be as stretchable as living tissue, it is implanted right onto the spinal cord, and can remain in contact with spinal cord without causing inflammation or tissue damage.

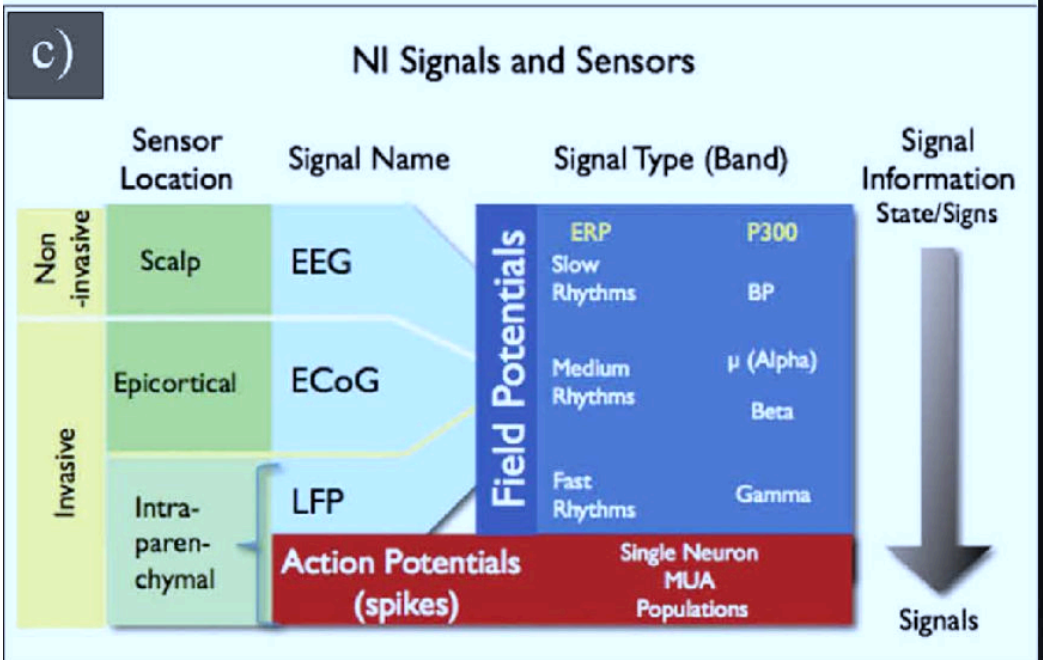


Infographic: Lionel Pousaz, Pascal Coderey / EPFL


a
Wireless transmitter
Analog-to-digital converter
8 mm
8 mm
Amplifier
15 mm
b
2D holes on mask
Drawing pillars with different diameters
Microneedle electrode with different length
c
Convex profile
Concave profile


a)
EEG
ECoG
LFP
Spikes
5-300 µV
< 100 Hz
0.01-5 mV
< 200 Hz
< 1 mV
< 200 Hz
~500 µV
0.1-7 kHz


b)
EEG
ECoG
Platform Array
Microwires
Multisite Probe
Cortex


c)
NI Signals and Sensors
Sensor Location
Signal Name
Signal Type (Band)
Signal Information State/Signs
Non -invasive
Invasive
Scalp
EEG
Epicortical
ECoG
Intra-paren-chymal
LFP
Field Potentials
ERP
P300
Slow Rhythms
BP
Medium Rhythms
µ (Alpha)
Beta
Fast Rhythms
Gamma
Action Potentials (spikes)
Single Neuron
MUA
Populations
Signals

EMOTIV EPOC+ EEG helmet

ResearchGate

EMOTIV EPOC+ EEG helmet and electrodes

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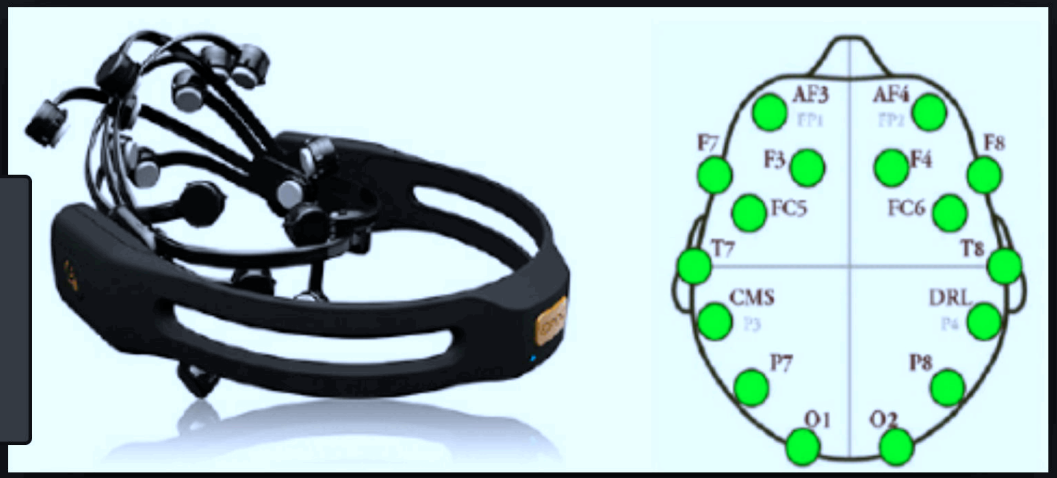

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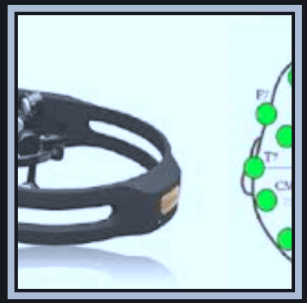

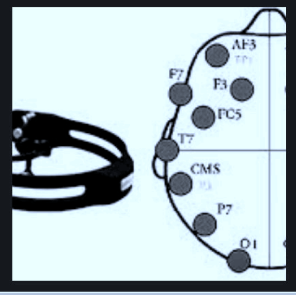

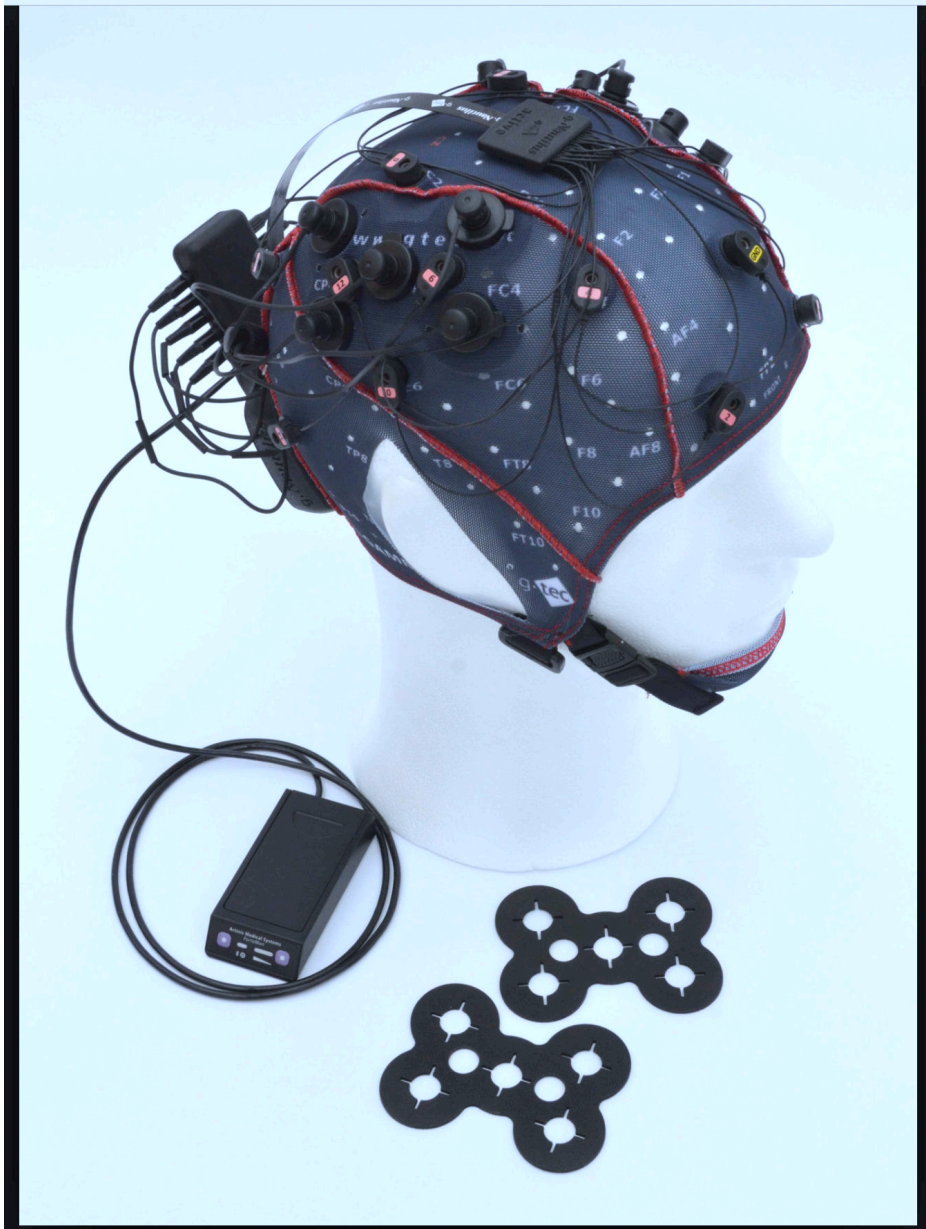

g.Nautilus-fNIRS wireless EEG

Guger Technologies

Nautilus has a built-in lithium ion batteries for the EE
for continuous recordings of up to 10 hours (32 char

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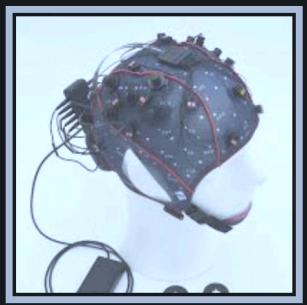
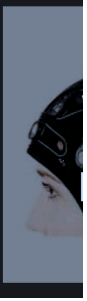
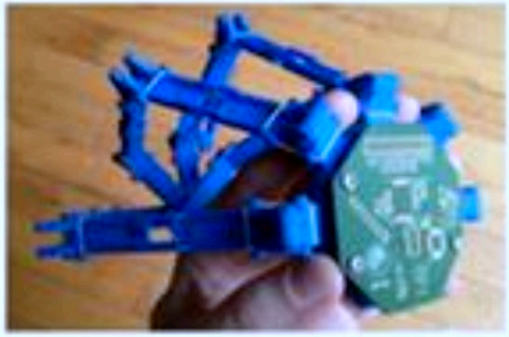




Spiderclaw V1

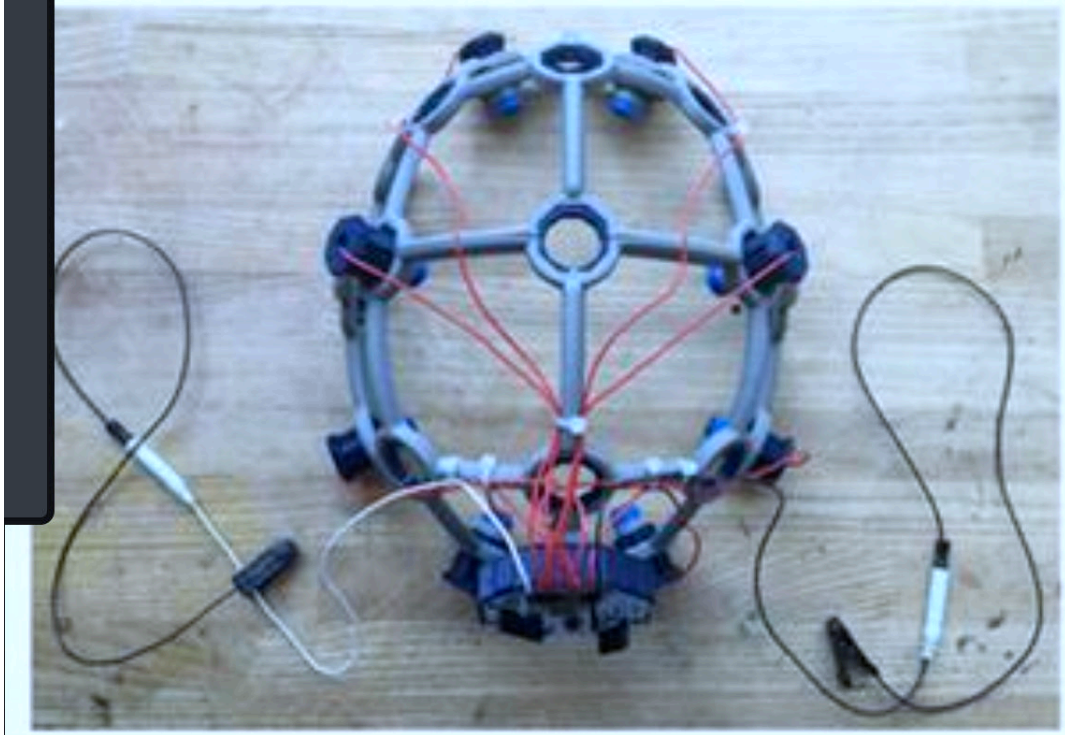
Spiderclaw V2



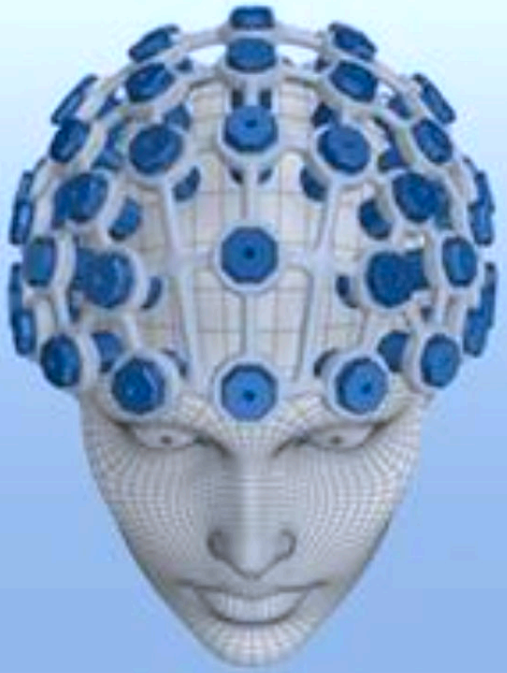
Ultracortex Mark I

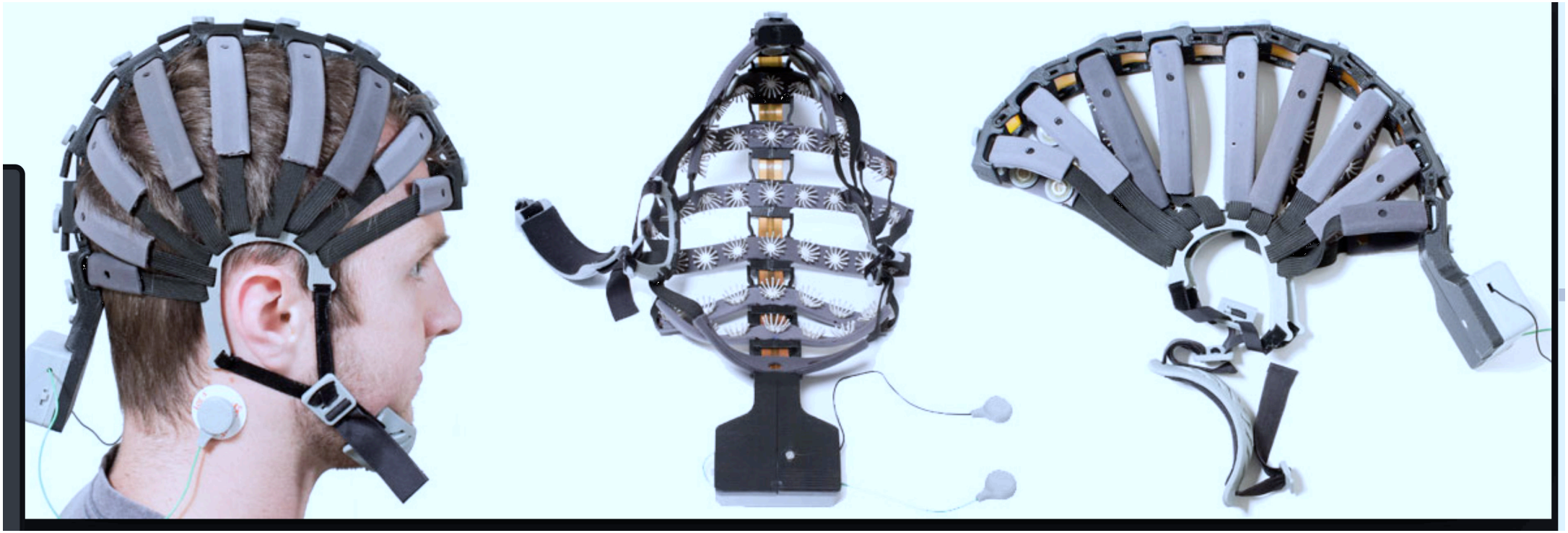
Ultracortex Mark II

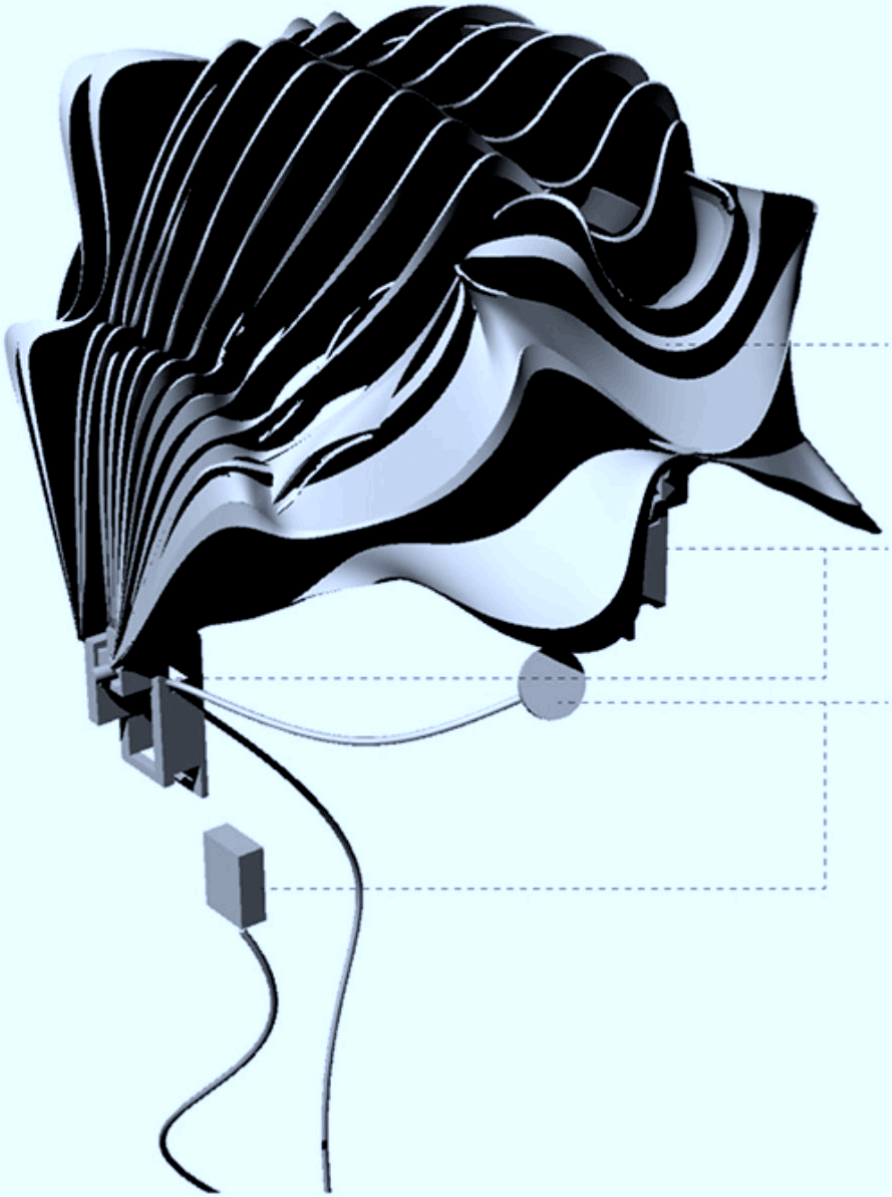
Ultracortex Mark III (current)



Ultracortex Mark IV (concept)







Multi-Material 3dPrinting

White: Solid: Vero white
Black: Flexible: Shore 60

Servos

"Attention" level are translated into actual motions of the helmet.

Brain Sensor

Neurosky's EEG chip and Mindflex headset have been redesigned.

SYNAPSE HELMET

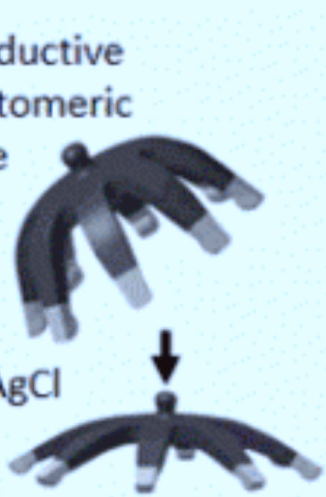
Dry EEG electrode

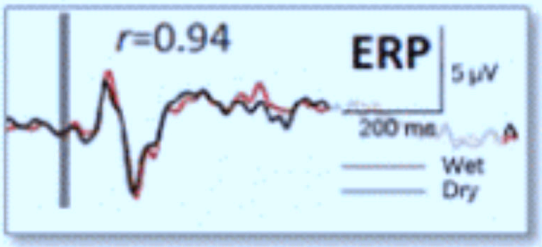
Wearable form-factor

64-channel dry-electrode wireless streaming EEG

Conductive Elastomeric Base

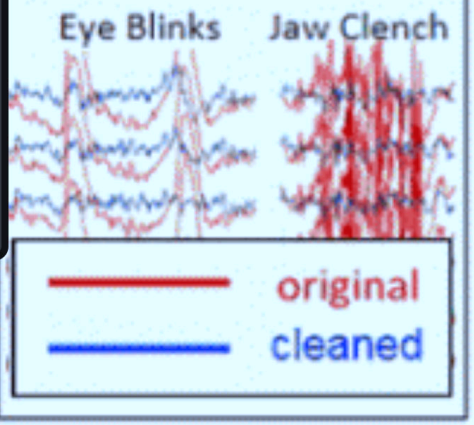
Ag/AgCl Tips



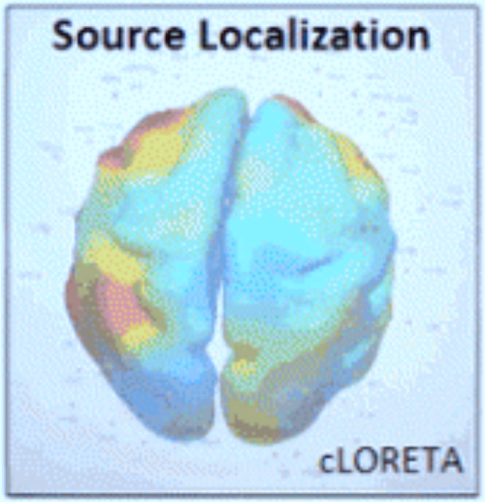


BCILAB / SIFT Online Data Analysis Pipeline

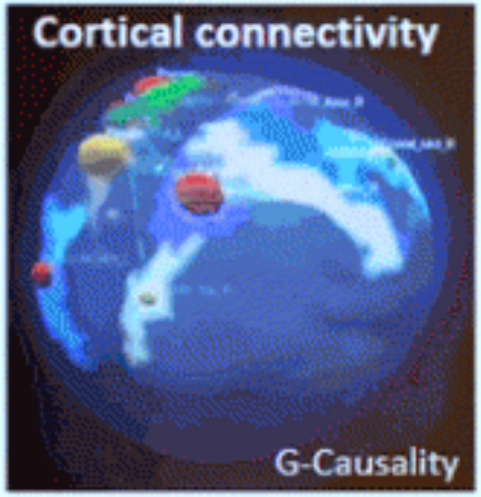
Artifact Removal



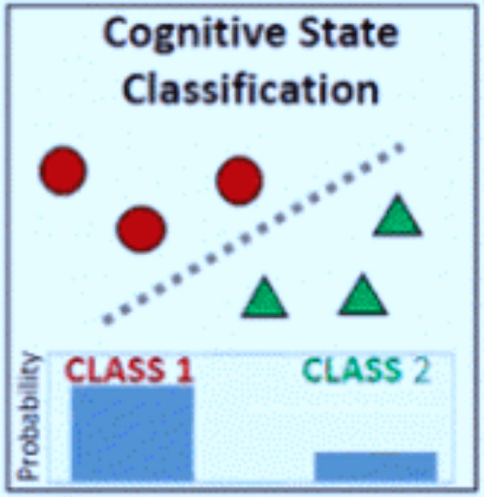
Source Localization



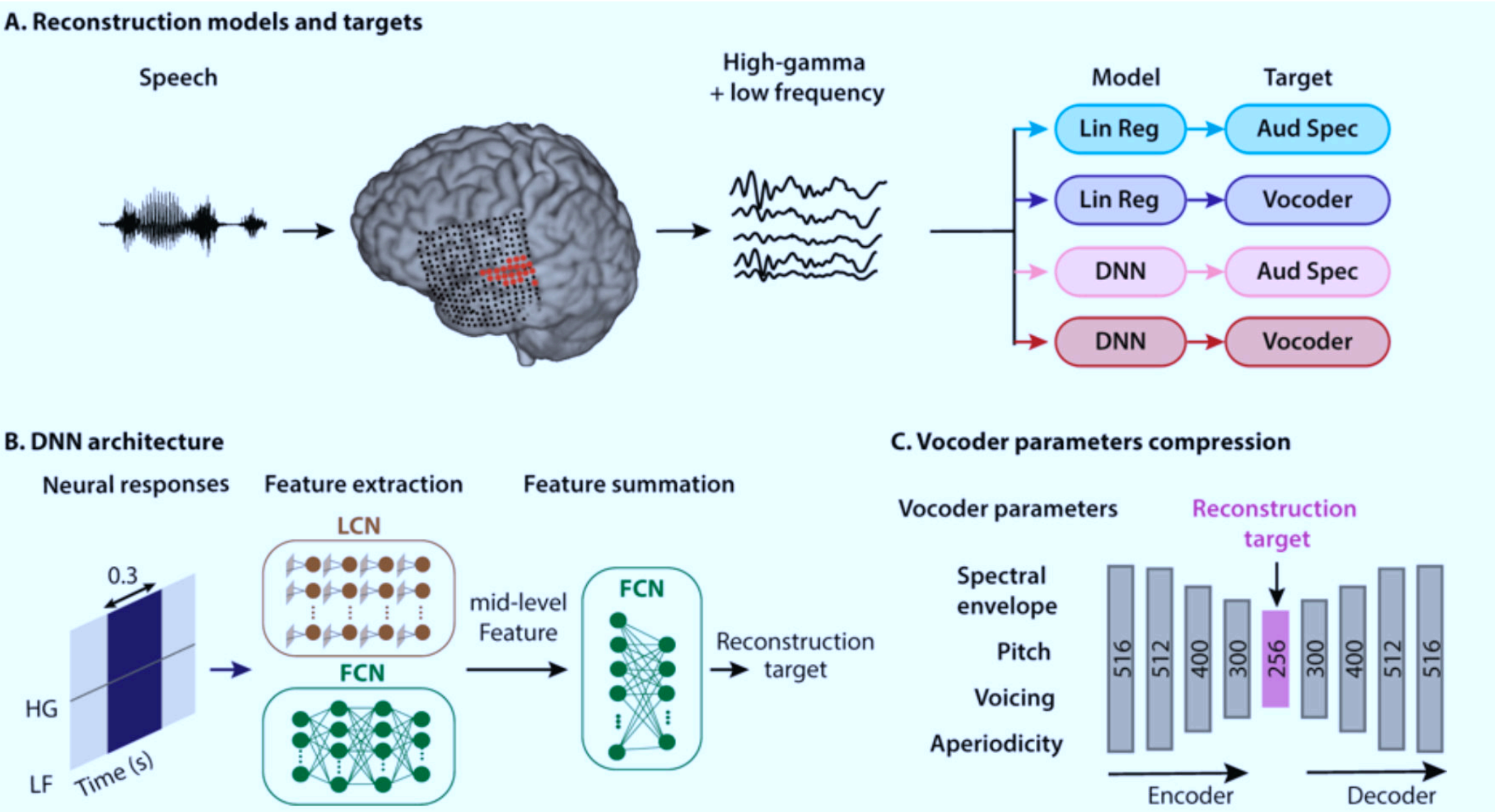
Cortical connectivity



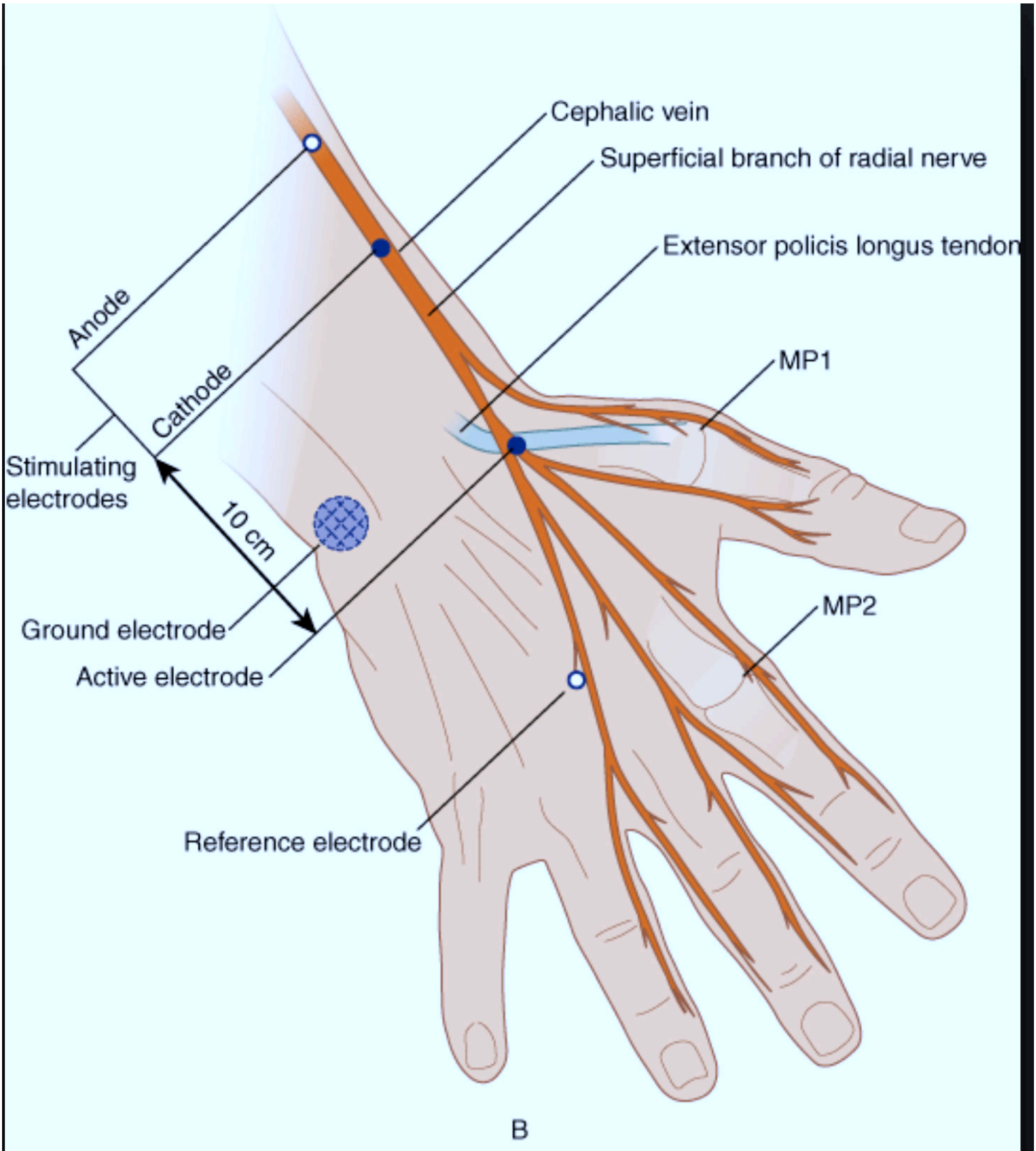
Cognitive State Classification



PORTABLE BRAIN MONITOR


A. Reconstruction models and targets
Speech
High-gamma
+ low frequency
Model
Target
Lin Reg
Aud Spec
Lin Reg
Vocoder
DNN
Aud Spec
DNN
Vocoder
B. DNN architecture
Neural responses
Feature extraction
Feature summation
LCN
FCN
0.3
HG
LF
Time (s)
mid-level
Feature
FCN
Reconstruction
target
C. Vocoder parameters compression
Vocoder parameters
Reconstruction
target
Spectral
envelope
Pitch
Voicing
Aperiodicity
516
512
400
300
256
300
400
512
516
Encoder
Decoder

samim | 1/12/19



B

Source: Prentice WE, Quillen WS, Underwood F: *Therapeutic Modalities in Rehabilitation*, 4thEdition: www.accessphysiotherapy.com

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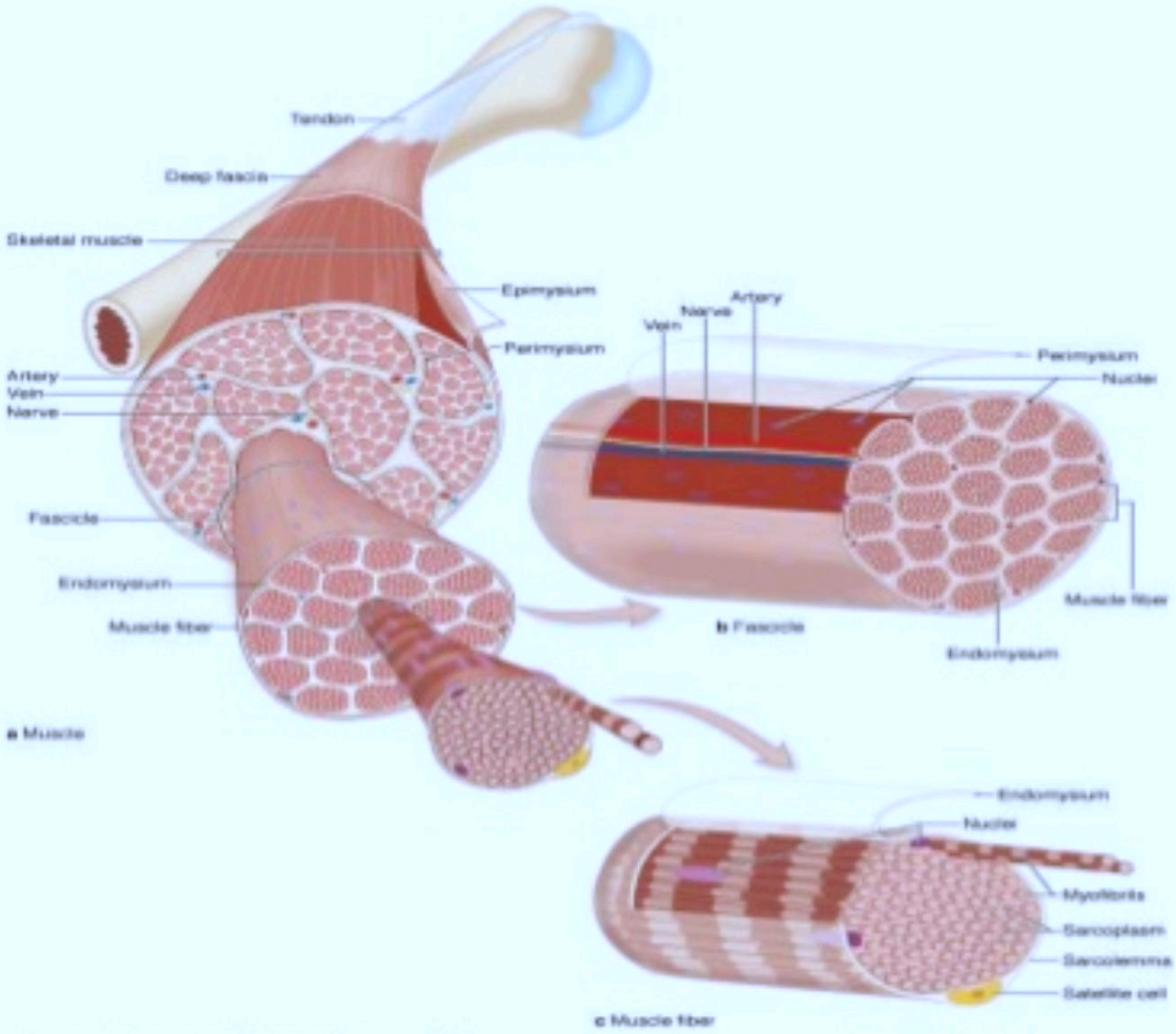
SKELETAL MUSCLE : STRUCTURE AND ORGANIZATION



Source: Mescher AL: Junqueira's Basic Histology: Text and Atlas, 12th Edition: http://www.accessmedicine.com
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- **Epimysium**

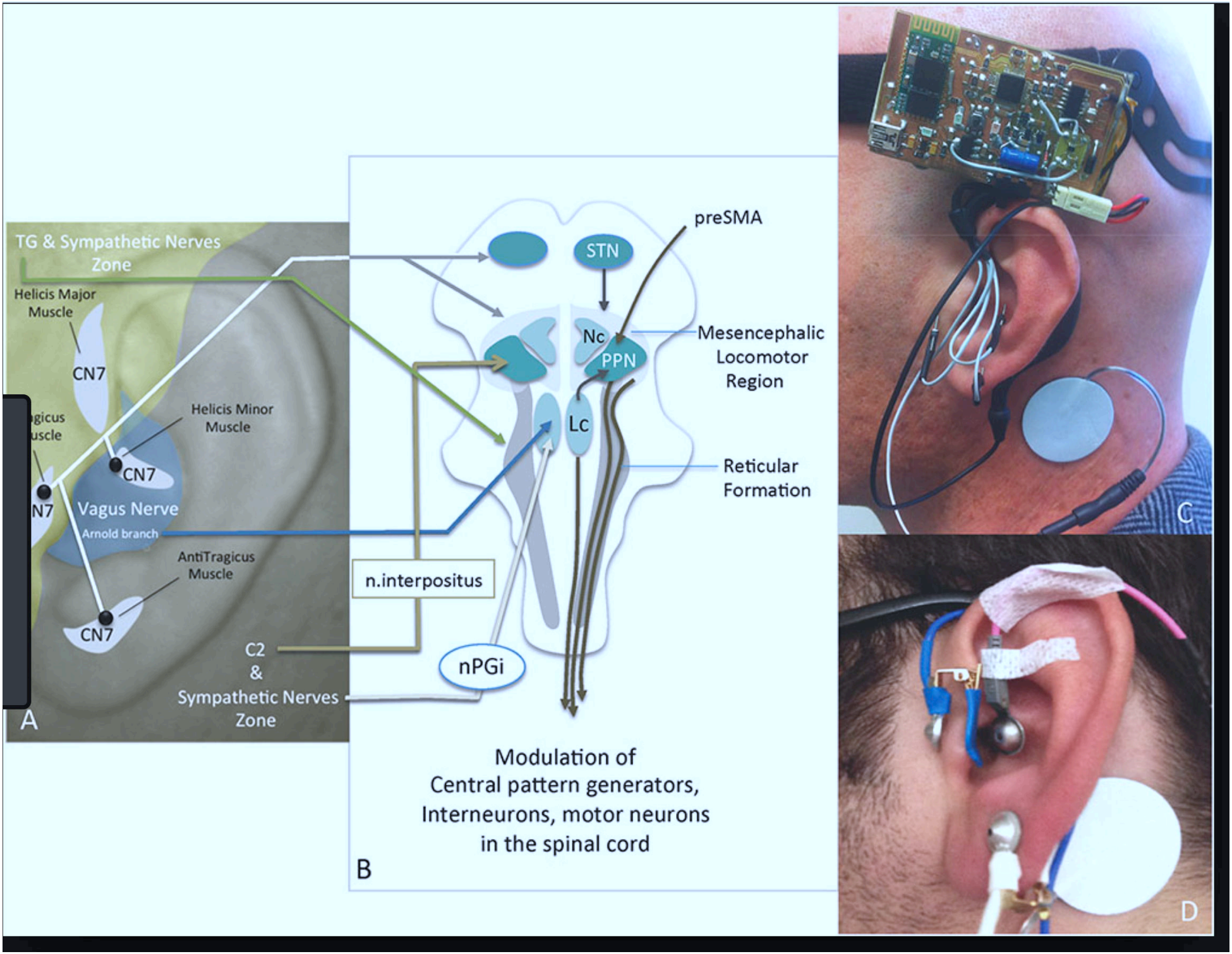
(surrounding entire muscle)

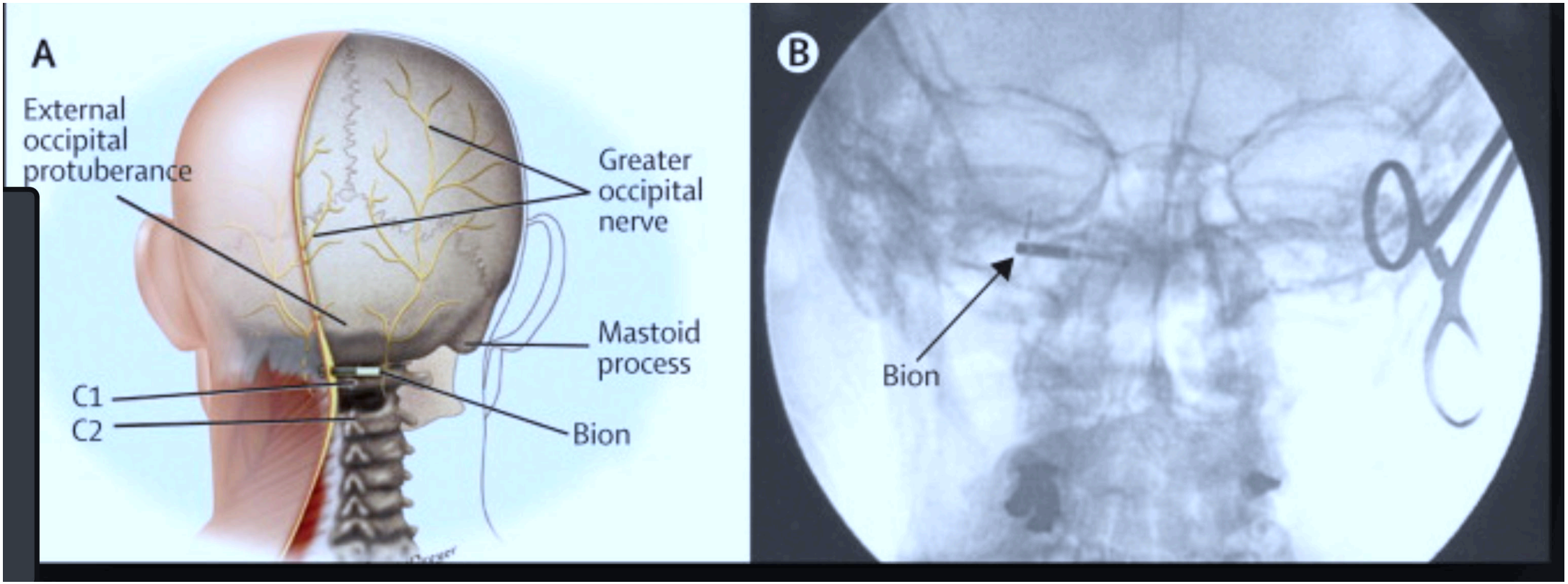
- **Perimysium**

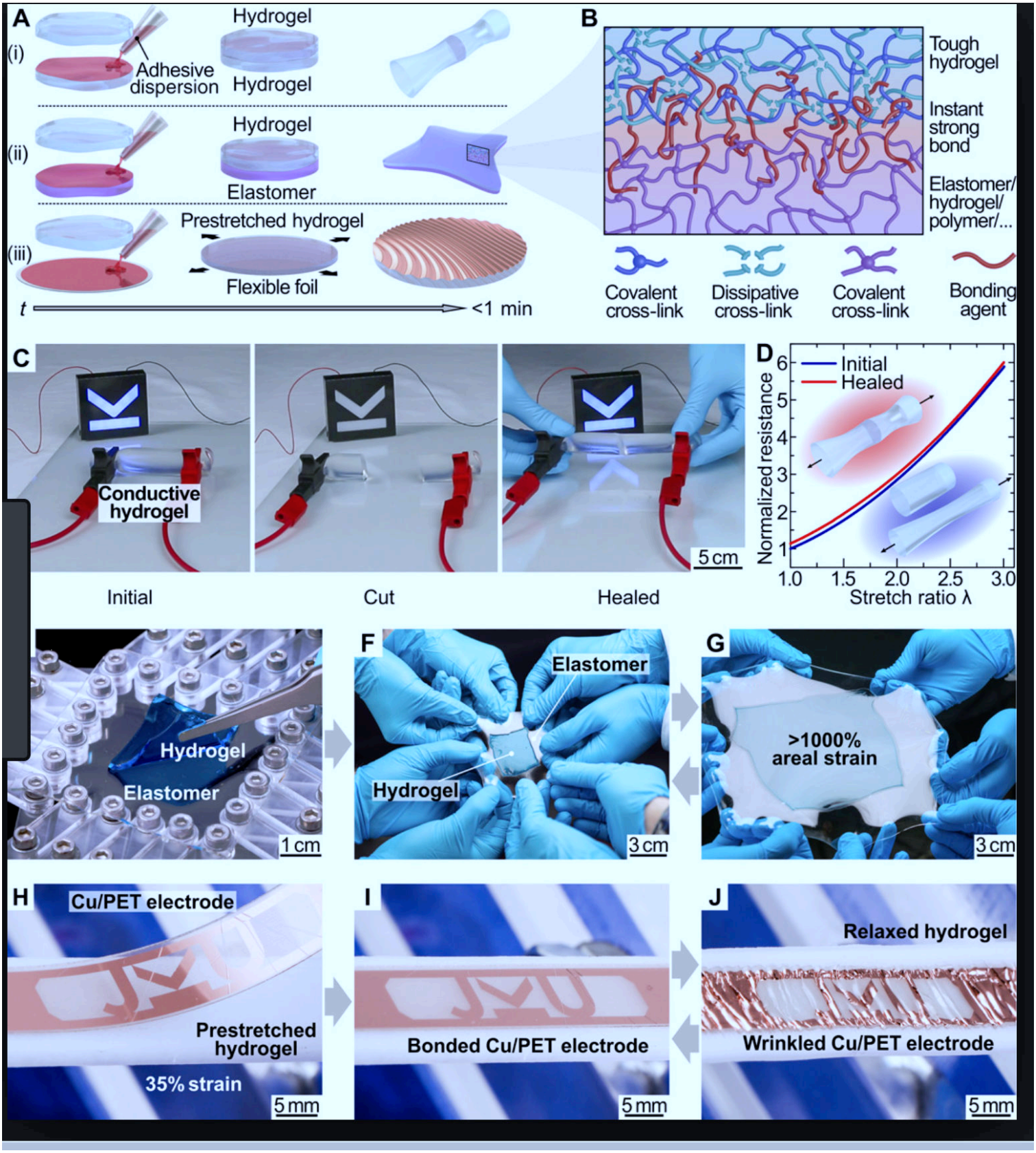
(Each fascicle of muscle fibers)

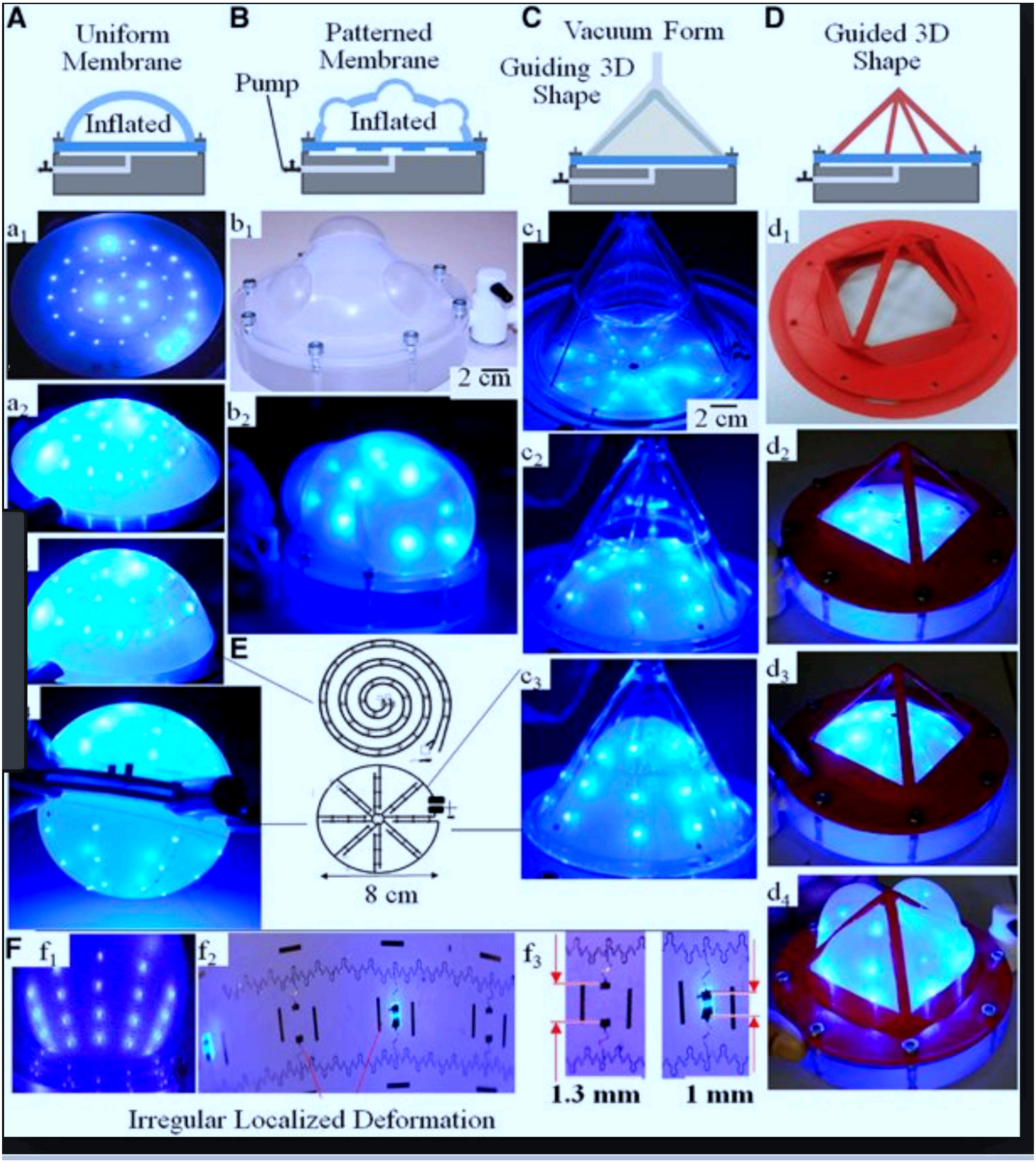
- **Endomysium**

(Individual muscle fibers)

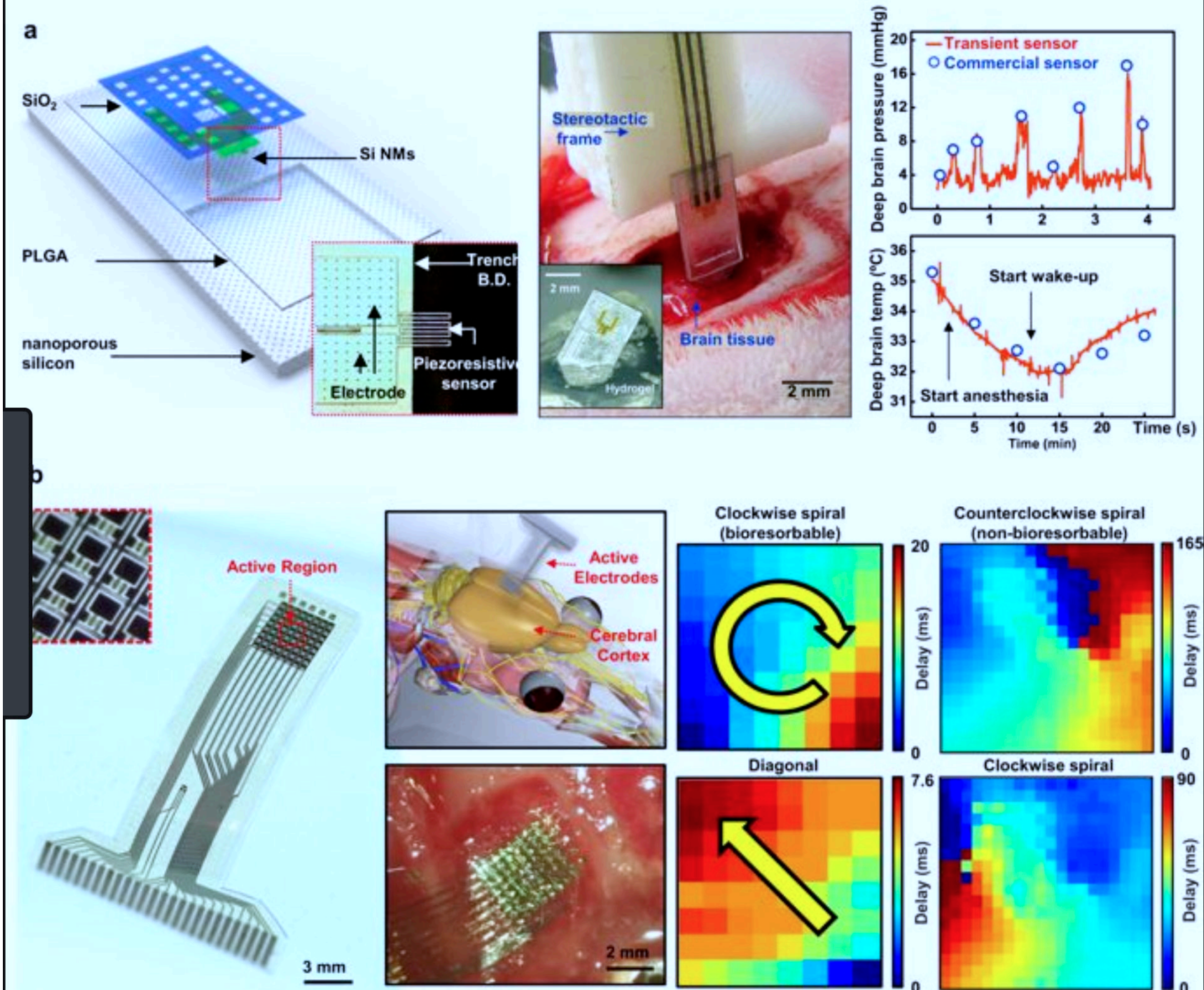

TG & Sympathetic Nerves Zone
Helicis Major Muscle
CN7
Helicis Minor Muscle
CN7
N7
Vagus Nerve
Arnold branch
AntiTragicus Muscle
CN7
C2 & Sympathetic Nerves Zone
A
preSMA
STN
Nc
PPN
Mesencephalic Locomotor Region
Lc
Reticular Formation
n.interpositus
nPGi
Modulation of Central pattern generators, Interneurons, motor neurons in the spinal cord
B
C
D

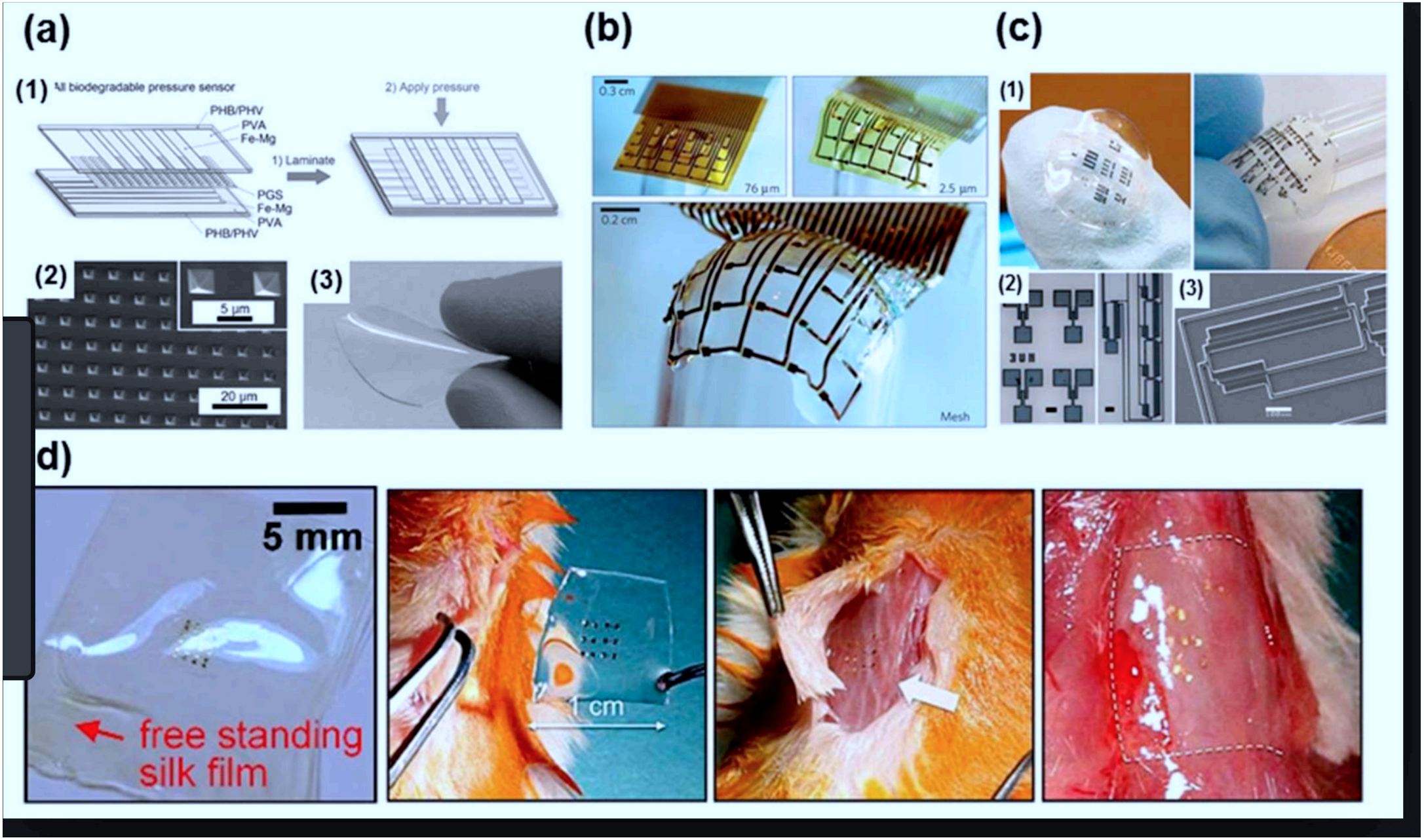

A
External occipital protuberance
Greater occipital nerve
Mastoid process
C1
C2
Bion
B
Bion

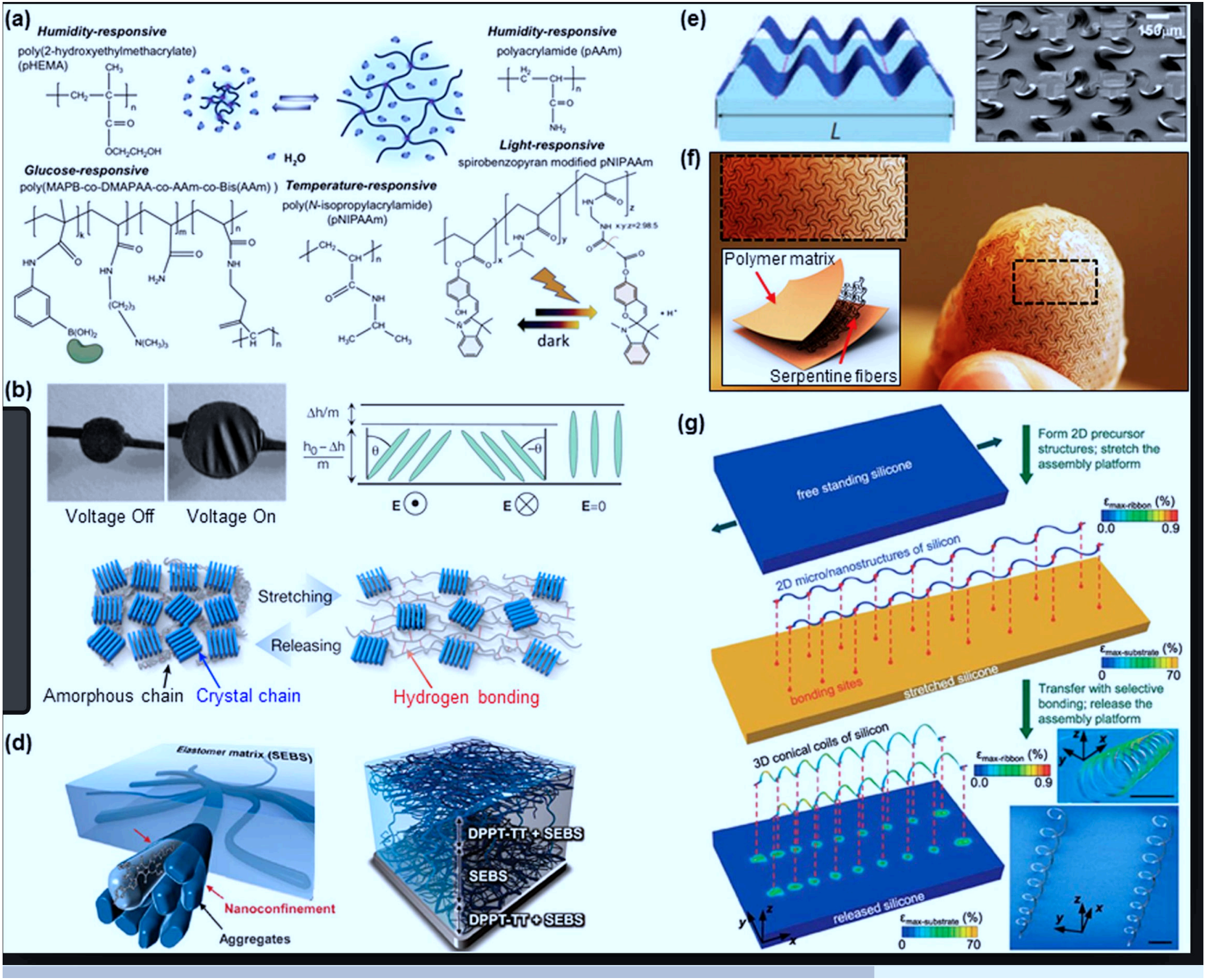

A
(i)
Adhesive dispersion
Hydrogel
Hydrogel
(ii)
Hydrogel
Elastomer
(iii)
Prestretched hydrogel
Flexible foil
t
<1 min
B
Tough hydrogel
Instant strong bond
Elastomer/ hydrogel/ polymer/...
Covalent cross-link
Dissipative cross-link
Covalent cross-link
Bonding agent
C
Conductive hydrogel
5 cm
Initial
Cut
Healed
D
Initial
Healed
Normalized resistance
Stretch ratio λ
F
Elastomer
Hydrogel
3 cm
G
>1000% areal strain
3 cm
Hydrogel
Elastomer
1 cm
H
Cu/PET electrode
Prestretched hydrogel
35% strain
5 mm
I
Bonded Cu/PET electrode
5 mm
J
Relaxed hydrogel
Wrinkled Cu/PET electrode
5 mm

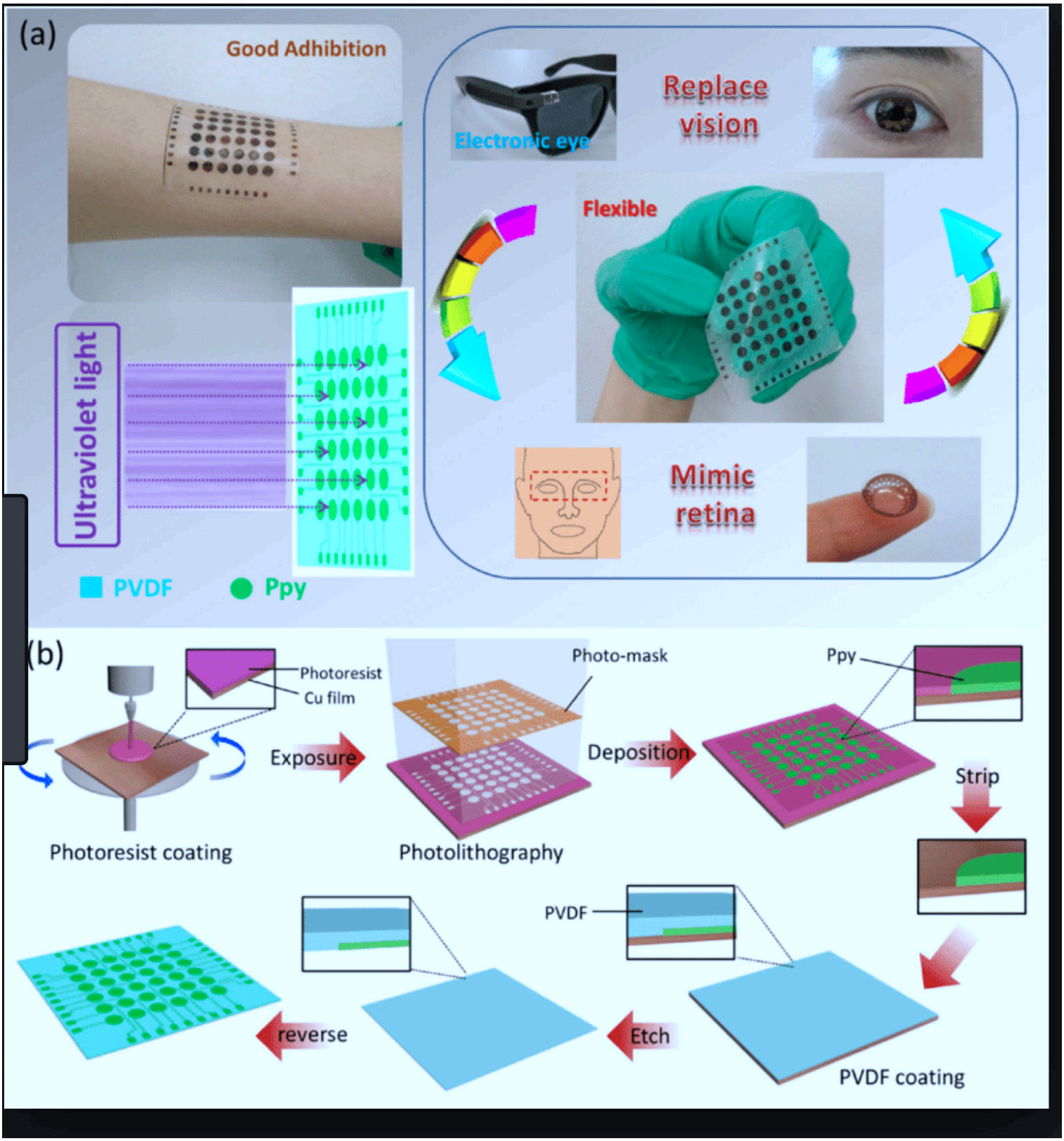

A
Uniform Membrane
Inflated
B
Patterned Membrane
Pump
Inflated
C
Vacuum Form
Guiding 3D Shape
D
Guided 3D Shape
a1
b1
2 cm
c1
2 cm
d1
a2
b2
c2
d2
E
c3
d3
8 cm
d4
F
f1
f2
f3
1.3 mm
1 mm
Irregular Localized Deformation

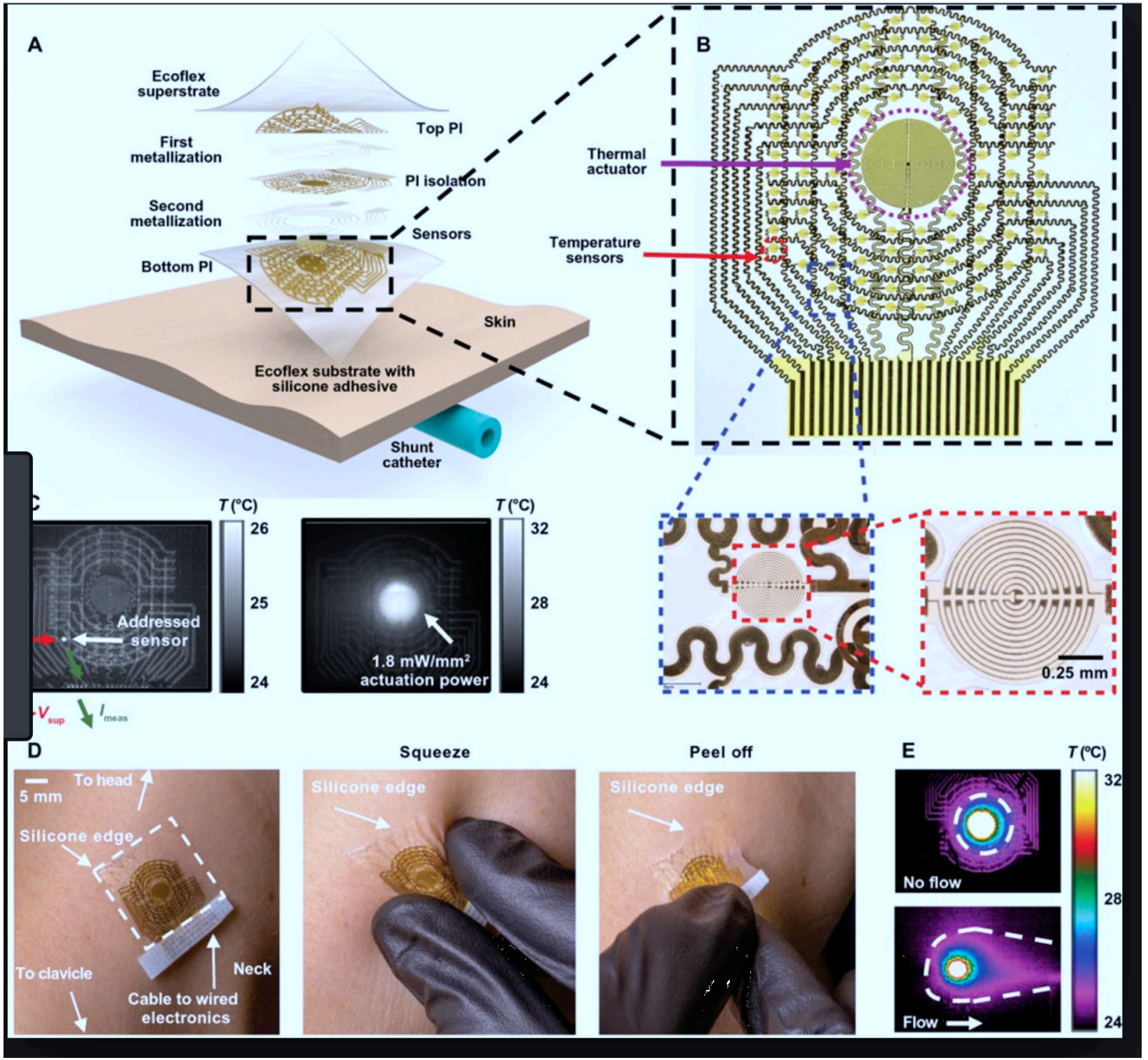
Transient Electronics 2

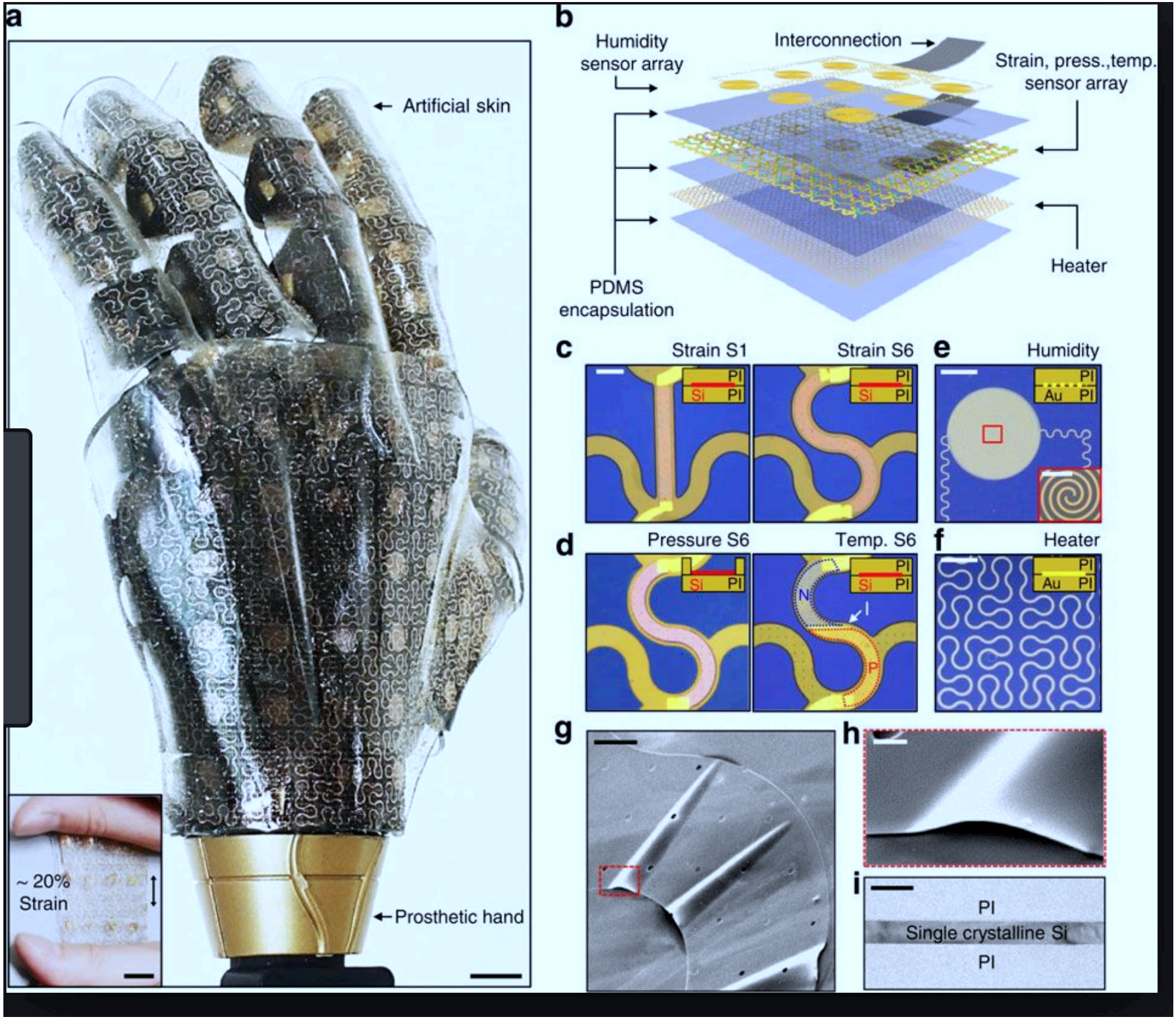


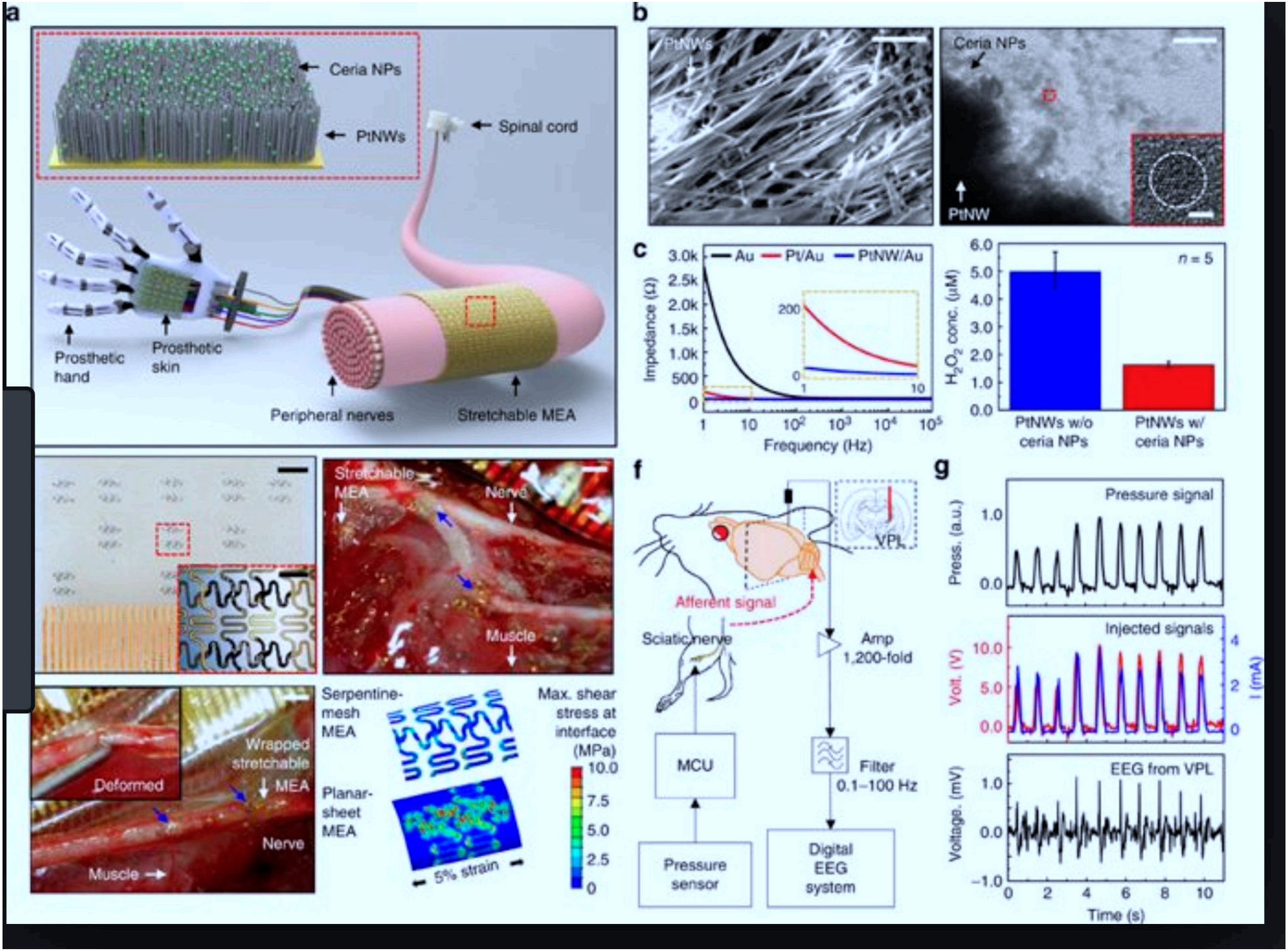

(a)
(1) All biodegradable pressure sensor
PHB/PHV
PVA
Fe-Mg
1) Laminate
2) Apply pressure
PGS
Fe-Mg
PVA
PHB/PHV
(2)
5 μm
20 μm
(3)
(b)
0.3 cm
76 μm
2.5 μm
0.2 cm
Mesh
(c)
(1)
(2)
(3)
d)
5 mm
free standing
silk film
1 cm

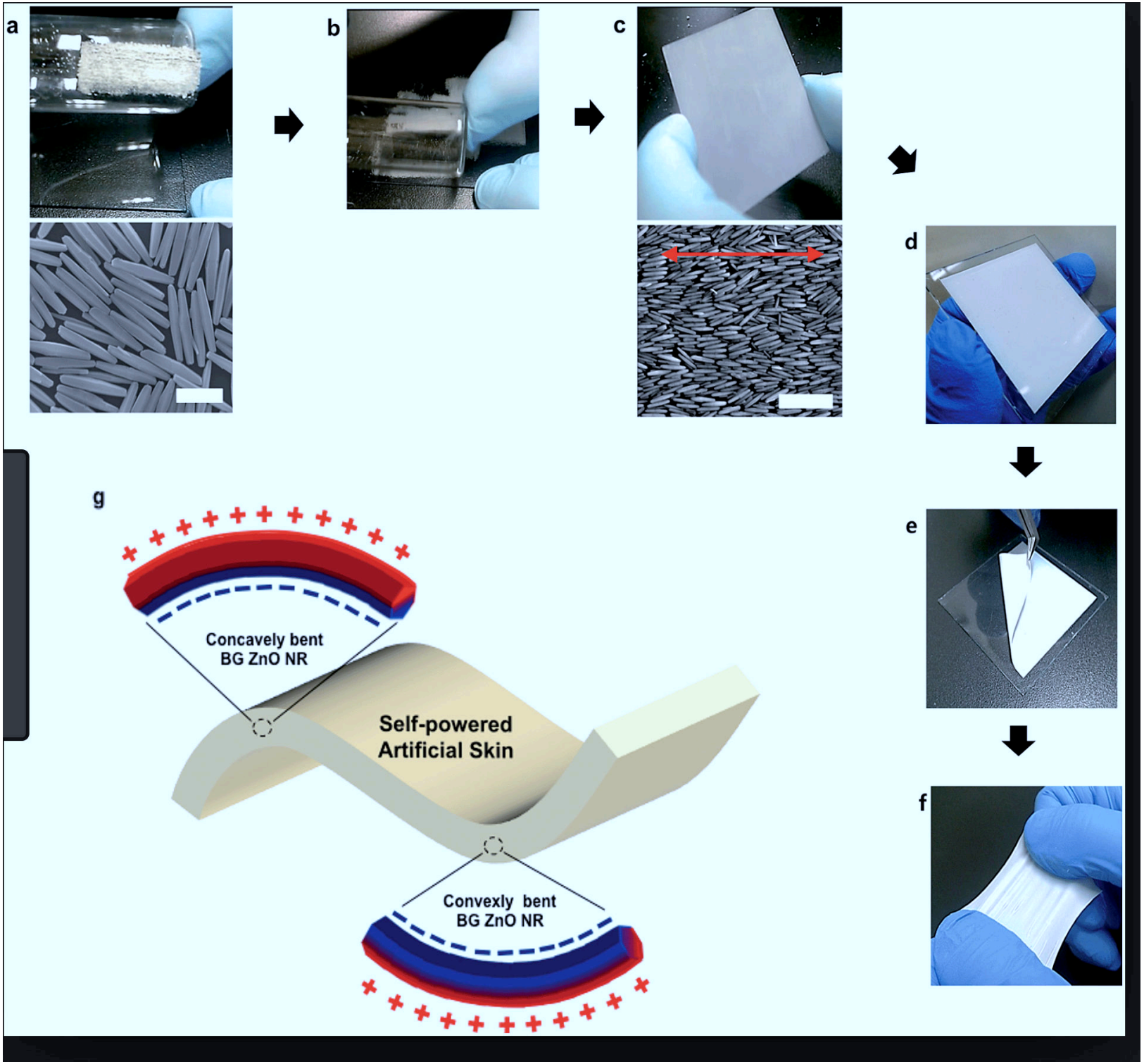

(a)
Humidity-responsive
poly(2-hydroxyethylmethacrylate)
(pHEMA)
Humidity-responsive
polyacrylamide (pAAm)
H2O
Light-responsive
spirobenzopyran modified pNIPAAm
Glucose-responsive
poly(MAPB-co-DMAPAA-co-AAm-co-Bis(AAm))
Temperature-responsive
poly(N-isopropylacrylamide)
(pNIPAAm)
dark
(b)
Voltage Off
Voltage On
Δh/m
E
E=0
Stretching
Releasing
Amorphous chain
Crystal chain
Hydrogen bonding
(d)
Elastomer matrix (SEBS)
Nanoconfinement
Aggregates
DPPT-TT + SEBS
SEBS
DPPT-TT◇SEBS
(e)
L
150 μm
(f)
Polymer matrix
Serpentine fibers
(g)
free standing silicone
Form 2D precursor structures; stretch the assembly platform
2D micro/nanostructures of silicon
bonding sites
stretched silicone
Transfer with selective bonding; release the assembly platform
3D conical coils of silicon
released silicone


(a)
Good Adhibition
Electronic eye
Replace vision
Flexible
Mimic retina
Ultraviolet light
PVDF
Ppy
(b)
Photoresist
Cu film
Photo-mask
Ppy
Exposure
Deposition
Strip
Photoresist coating
Photolithography
PVDF
reverse
Etch
PVDF coating

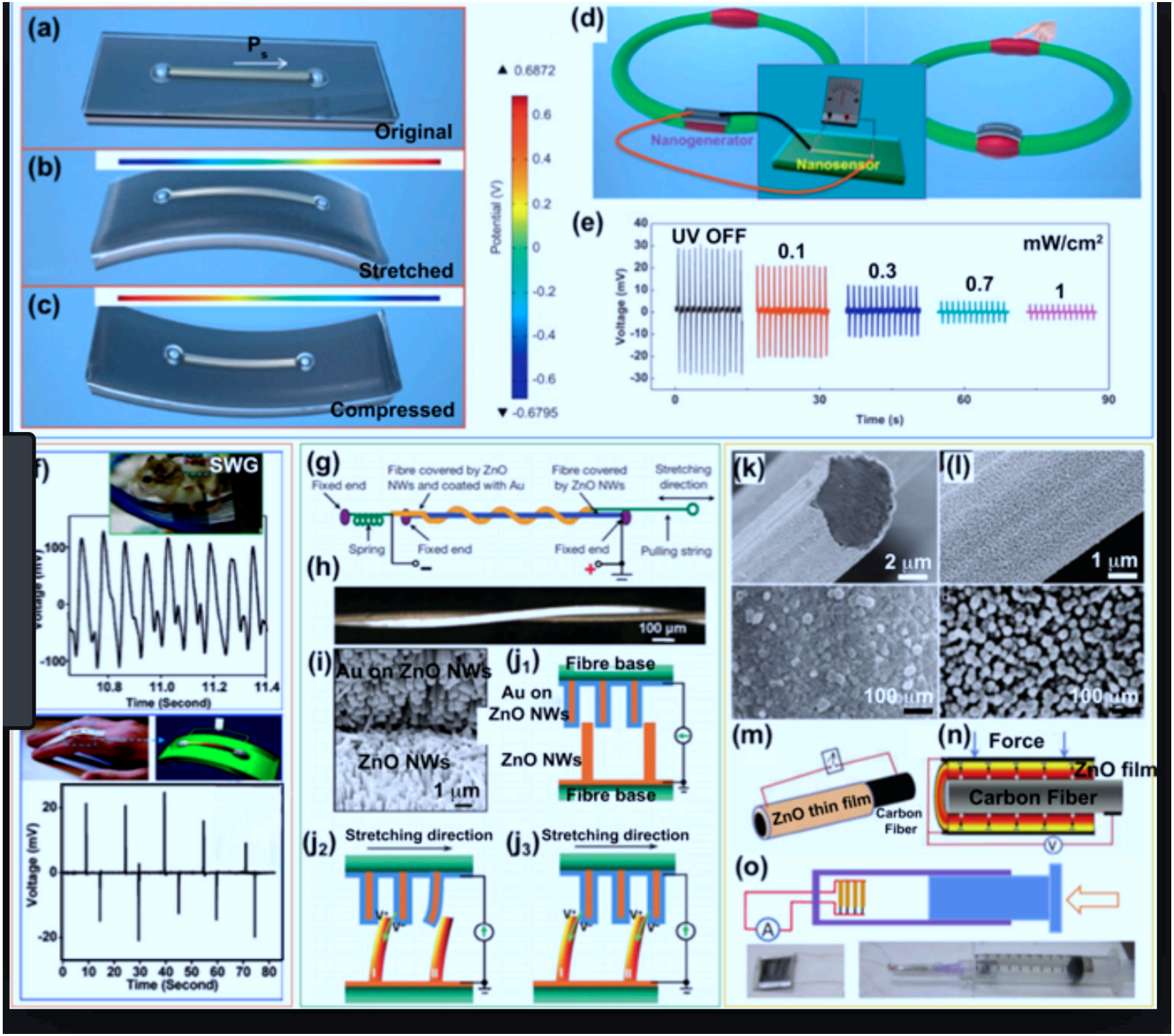

A
Ecoflex superstrate
Top PI
First metallization
PI isolation
Second metallization
Sensors
Bottom PI
Skin
Ecoflex substrate with silicone adhesive
Shunt catheter
B
Thermal actuator
Temperature sensors
0.25 mm
C
T (°C)
26
25
24
Addressed sensor
T (°C)
32
28
24
1.8 mW/mm²
actuation power
V sup
I meas
D
5 mm
To head
Silicone edge
To clavicle
Neck
Cable to wired electronics
Squeeze
Silicone edge
Peel off
Silicone edge
E
T (°C)
32
28
24
No flow
Flow

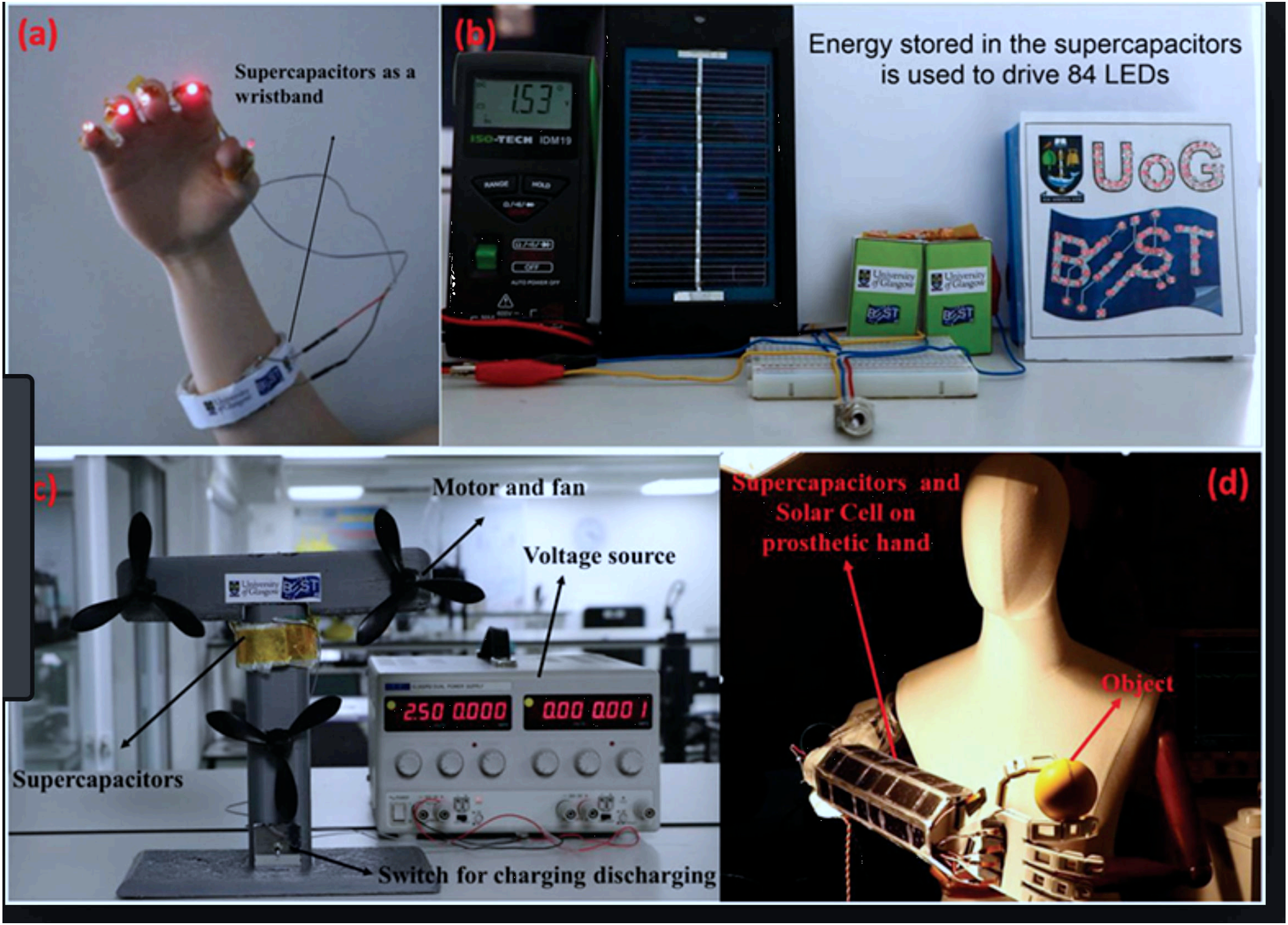

a
Artificial skin
~ 20%
Strain
Prosthetic hand
b
Humidity
sensor array
Interconnection
Strain, press.,temp.
sensor array
PDMS
encapsulation
Heater
c
Strain S1
Strain S6
PI
Si
PI
e
Humidity
PI
Au
PI
d
Pressure S6
Temp. S6
N
I
P
f
Heater
g
h
i
PI
Single crystalline Si
PI

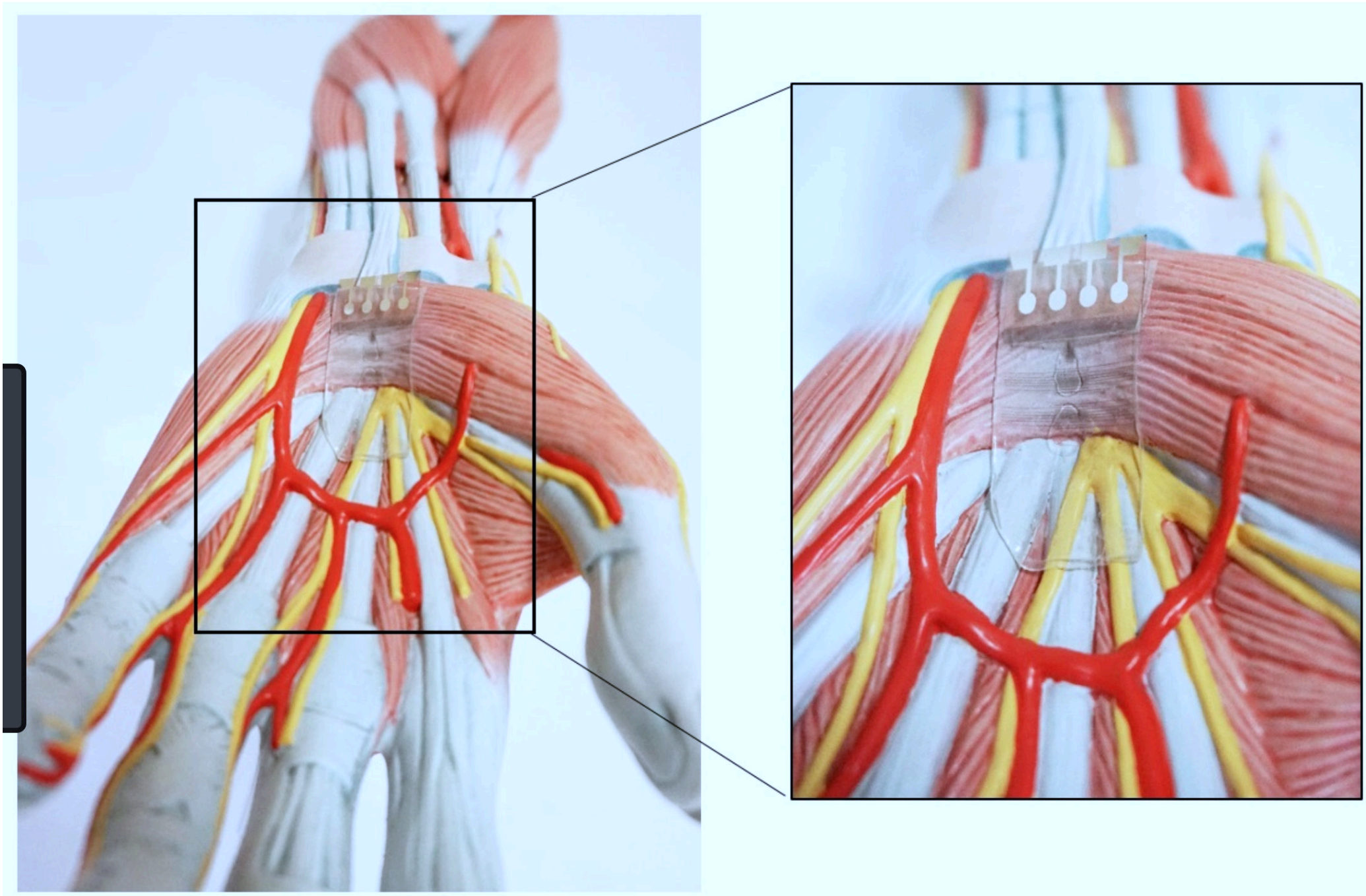

a
Ceria NPs
PtNWs
Spinal cord
Prosthetic hand
Prosthetic skin
Peripheral nerves
Stretchable MEA
b
PtNWs
Ceria NPs
PtNW
c
Au
Pt/Au
PtNW/Au
Impedance (Ω)
Frequency (Hz)
H_2O_2 conc. (μM)
n = 5
PtNWs w/o ceria NPs
PtNWs w/ ceria NPs
Stretchable MEA
Nerve
Muscle
Deformed
Wrapped stretchable MEA
Nerve
Muscle
Serpentine-mesh MEA
Planar-sheet MEA
5% strain
Max. shear stress at interface (MPa)
f
VPL
Afferent signal
Sciatic nerve
Amp 1,200-fold
MCU
Filter 0.1–100 Hz
Pressure sensor
Digital EEG system
g
Pressure signal
Press. (a.u.)
Injected signals
Volt. (V)
I (mA)
EEG from VPL
Voltage. (mV)
Time (s)

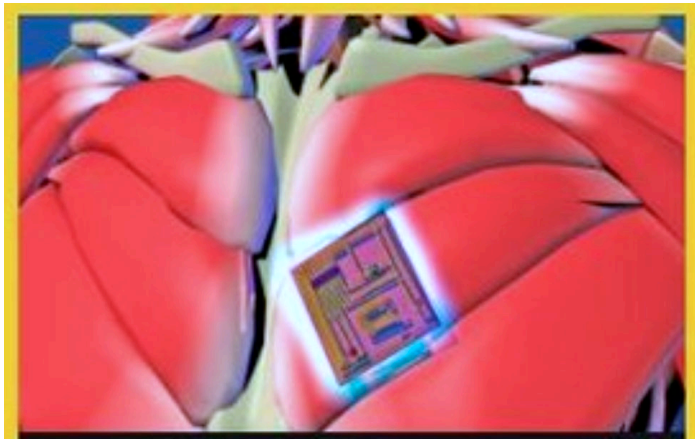

a
b
c
d
e
f
g
Concavely bent
BG ZnO NR
Self-powered
Artificial Skin
Convexly bent
BG ZnO NR

(a)
A/D Conversion & transmit
Touch Sensors
Temperature Sensor
Analog Output
Signal Conditioning
Local Memory
Thermoelectric Energy
(b)
Sensors/Actuators Array (Tactile, Light; Gas etc.)
Acvitve/Passive Electronic Components and Circuits
Flexible Energy Harvestors (thermoelectric etc.)
(c)
(d)
(e)
8 mm
Tweezers
1 cm
(f)
(g)
(h)
(i)


(a)
P_s
Original
(b)
Stretched
(c)
Compressed
▲ 0.6872
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
▼ -0.6795
Potential (V)
(d)
Nanogenerator
Nanosensor
(e)
UV OFF
0.1
0.3
0.7
1
mW/cm²
Voltage (mV)
Time (s)
(f)
SWG
Voltage (mV)
Time (Second)
Voltage (mV)
Time (Second)
(g)
Fixed end
Fibre covered by ZnO NWs and coated with Au
Fibre covered by ZnO NWs
Stretching direction
Spring
Fixed end
Fixed end
Pulling string
(h)
100 μm
(i)
Au on ZnO NWs
ZnO NWs
1 μm
(j1)
Fibre base
Au on ZnO NWs
ZnO NWs
Fibre base
(j2)
Stretching direction
(j3)
Stretching direction
(k)
2 μm
100 μm
(l)
1 μm
100 μm
(m)
ZnO thin film
Carbon Fiber
(n)
Force
ZnO film
Carbon Fiber
(o)

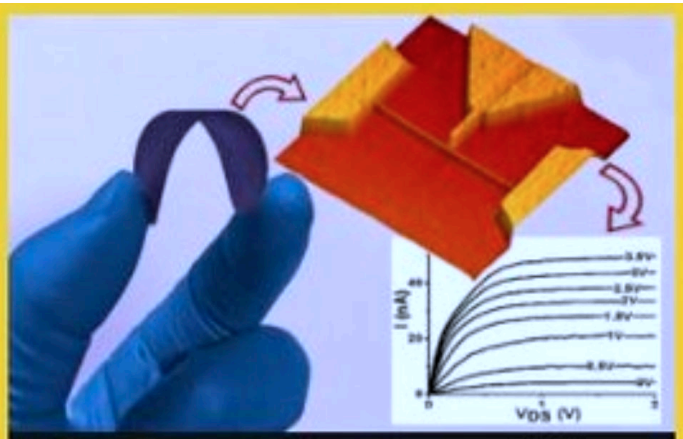

(a)
Supercapacitors as a wristband
(b)
Energy stored in the supercapacitors is used to drive 84 LEDs
UoG
BEST
(c)
Motor and fan
Voltage source
Supercapacitors
Switch for charging discharging
(d)
Supercapacitors and Solar Cell on prosthetic hand
Object





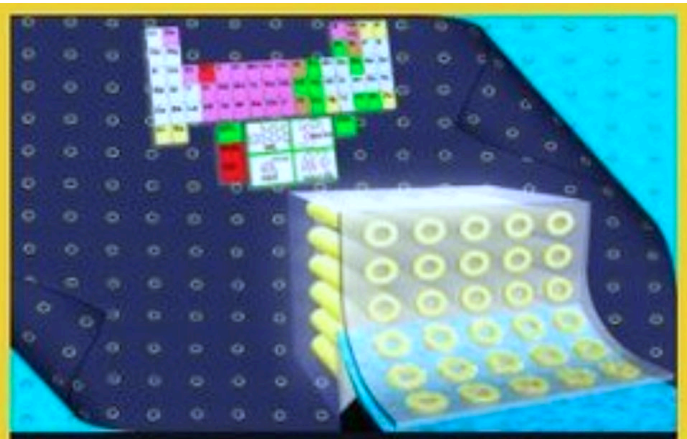
Implantable Devices

Flexible and Biocompatible Electronics



Flexible Electronics

Flexible and Stretchable Electronics

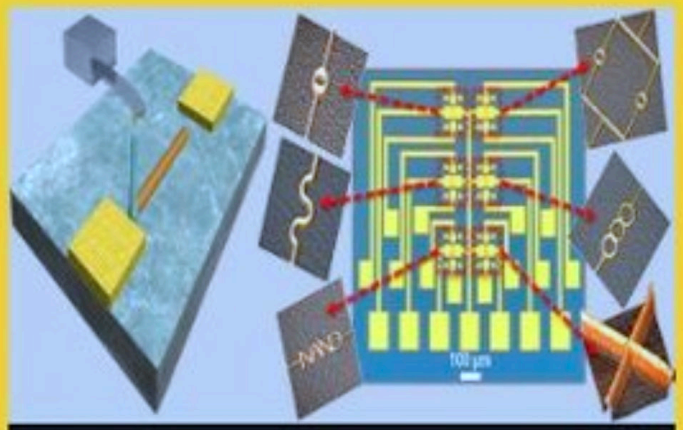


Flexible Photonics

Bendable Photonic Components

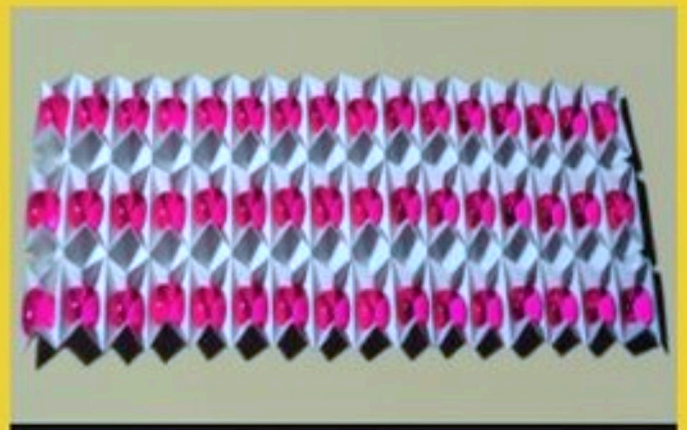
Soft Robotics

Stretchable Robotic Actuators



Unconventional Nanomanufacturing

Novel Nanofabrication Techniques



Foldable Paper-Based Devices

Low-cost Flexible Devices

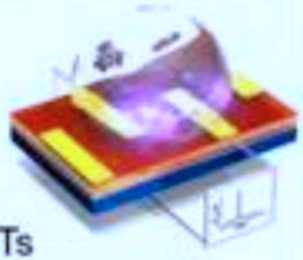
Au
CDH
Au
BOx
e-skin on contact-lens self-powered by biofuel cells
Thermoelectric Generator
Commertial Finger sensor
Electronics
Wearable e-skin self-powered by thermoelectric generators
Health care e-skin self-powered by triboelectric generators
Sun Light
Energy-autonomous tactile and flexible e-skin self-powered by solar cells
Solar cell
e-skin on fabrics, self-powered by piezoelectric generators
Self-powered e-skin
Energy Harvesting
Energy Storage
emical Energy
cro-BFC (2.4 μW/cm²)
zymatic-BFC (32 μW/cm²)
hermal Energy
Nanostructures (160 μW/K)
Bulk (243 μW/K)
Mechanical Energy
Triboelectrics (0.27 mW/cm²)
Electromagnetics (2.2 mW/cm²)
Piezoelectrics (2.7 mW/cm³)
Light Energy
DSSCs (11.8 mW/cm²)
Organic PVs (13.3 mW/cm²)
MJ Solid State PVs (34.5 mW/cm²)
Li Batteries
LiMnTiO4/MWCNT (0.16 Ah/g)
HsGDY electrode (1.05 Ah/g)
MoS2 NSs/CNP electrode (1.09 Ah/g)
Si NW@G@rGO electrode (1.6 Ah/g)
Supercapacitors
Carbon woven fabric CWF/PANI (28.21 μWh/cm²)
Fiber-shaped asymmetric supercapacitor (53.3 μWh/cm²)
Textile based NCT @ NiAl-LDH (134 μWh/cm²)
Carbon cloth based Ni/Co3O4 (240 μWh/cm²)
Cloth based carbon network/polyaniline/MnO2 (413 μWh/cm²)

Electronic-skin

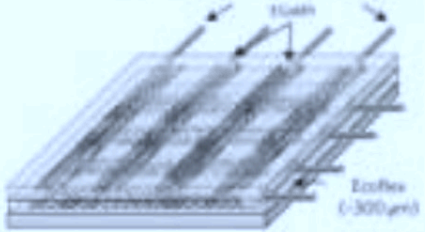
The Electronic Skin Concept-"Super Skin"

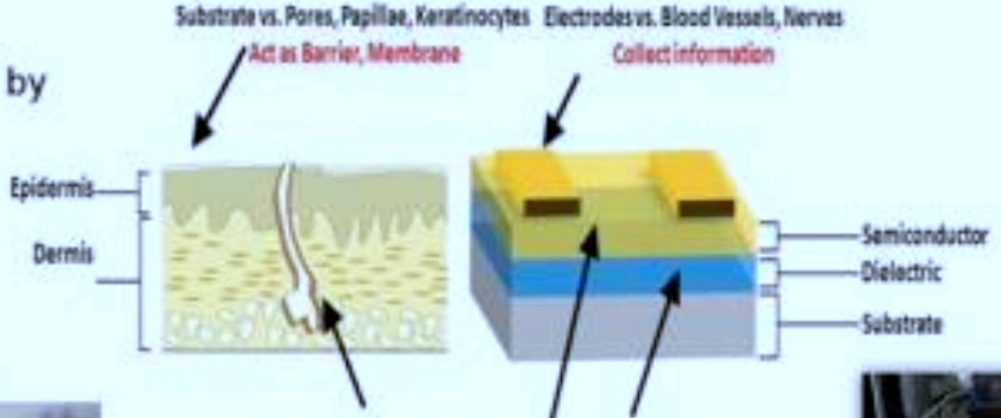
Integrated sensing skin (touch, chemical, biological and temperature sensing built on flexible and stretchable substrates that are biocompatible and biodegradable powered by stretchable solar cells and batteries

Chemical and Biosensors

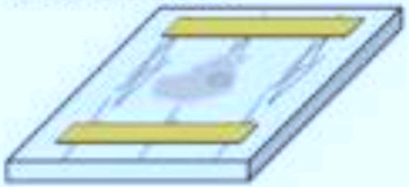


Transparent e-skin enabled by CNT nano springs

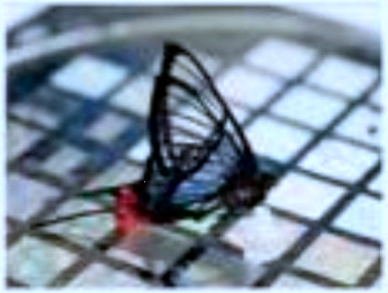




Cell on CNTs

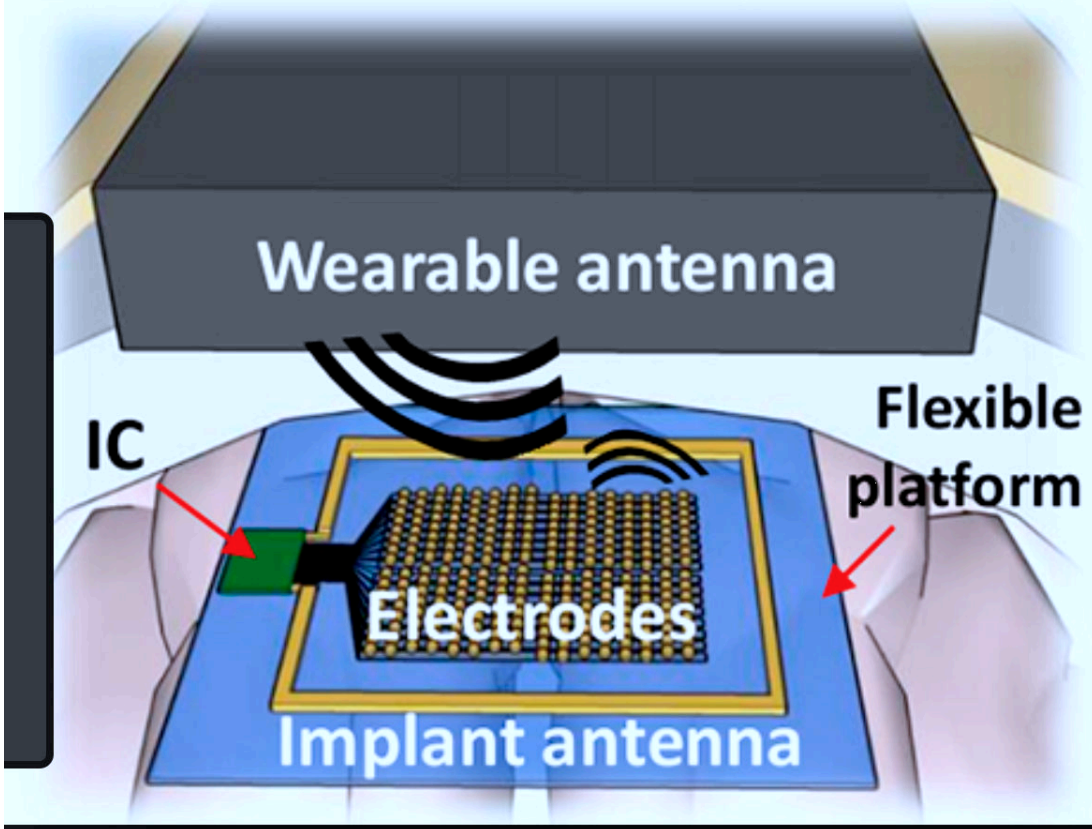


Ultra-sensitive touch sensors

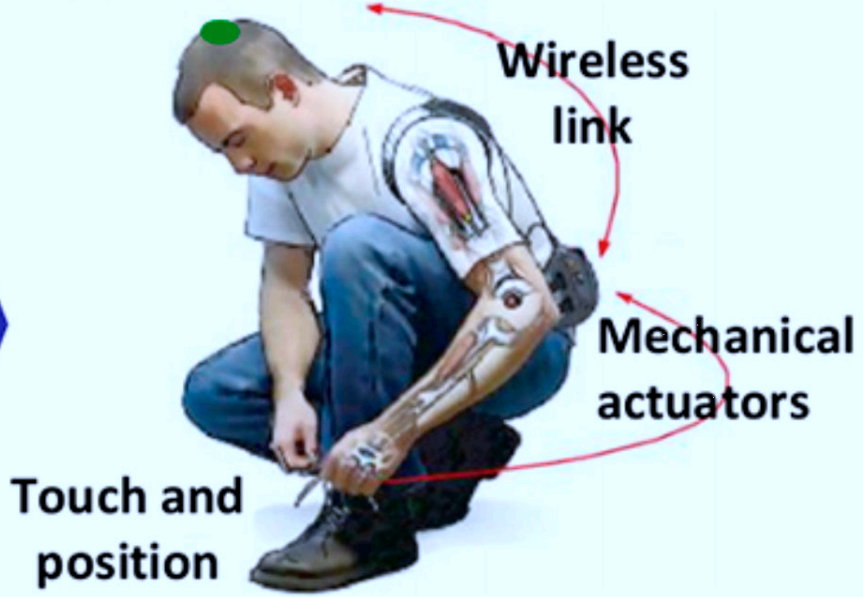


Selective Group Pubs: (1) PNAS, 105, 12134-12139, 2008; (2) Nature Materials, 9, 859-864, 2010; (3) Nature Nanotech, 6, 788, 2011; (3) Adv Mat, 22, 4452-4456, 2010; (4) Accounts. Chem. Rev., ASAP, 2012

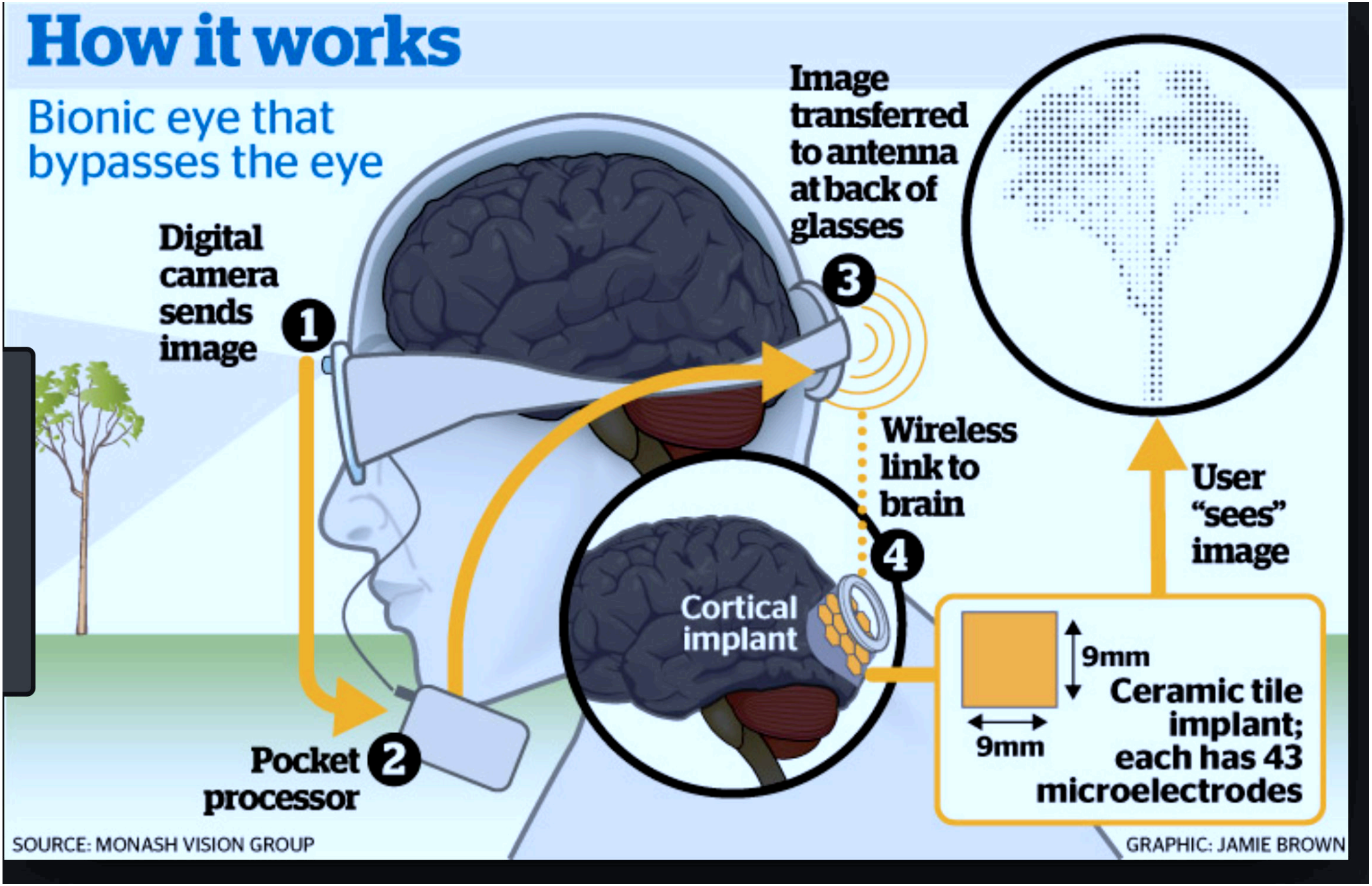
RFID-inspired wireless power and data telemetry

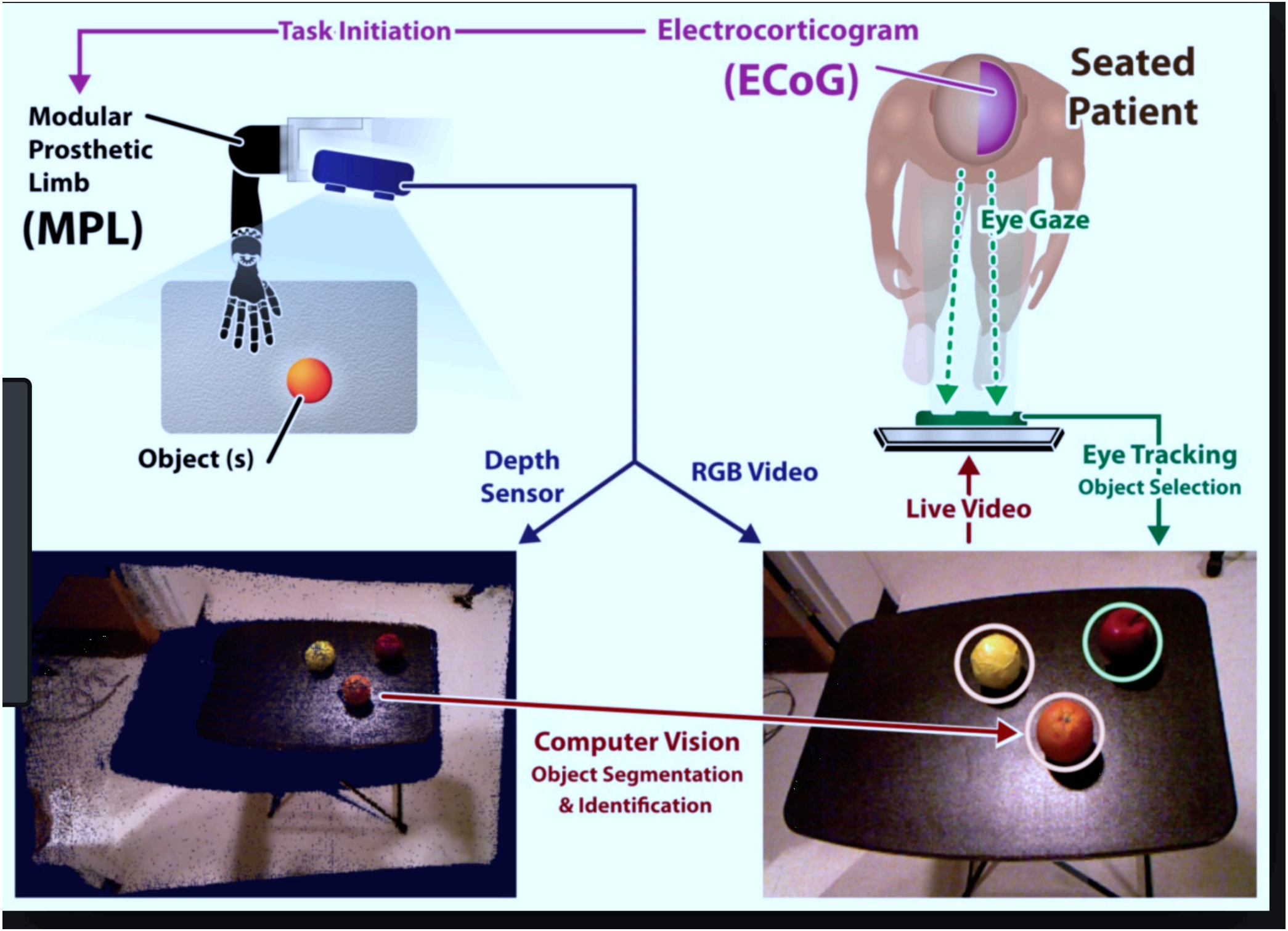


Wireless brain-machine interface

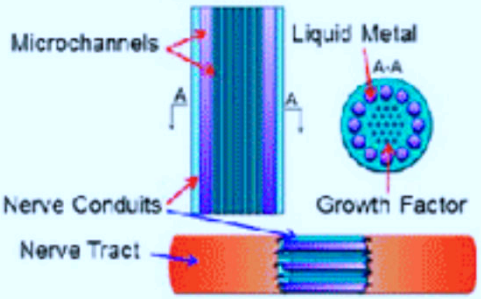


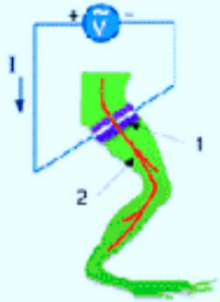
Lebedev & Nicolelis, "Brain-machine interfaces: past, present and future," *Trends Neurosci.*, 29(9) 2006.

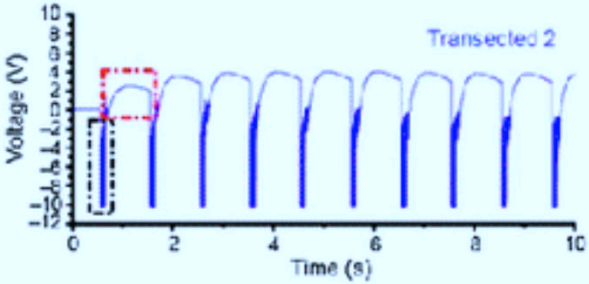

How it works
Bionic eye that bypasses the eye
Digital camera sends image
1
Pocket processor
2
Image transferred to antenna at back of glasses
3
Wireless link to brain
4
Cortical implant
User "sees" image
9mm
9mm
Ceramic tile implant; each has 43 microelectrodes
SOURCE: MONASH VISION GROUP
GRAPHIC: JAMIE BROWN


Task Initiation
Electrocorticogram
(ECoG)
Seated
Patient
Modular
Prosthetic
Limb
(MPL)
Eye Gaze
Object (s)
Depth
Sensor
RGB Video
Eye Tracking
Object Selection
Live Video
Computer Vision
Object Segmentation
& Identification

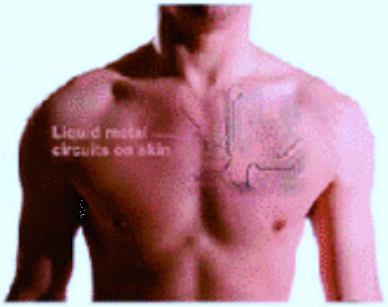
Implantable devices

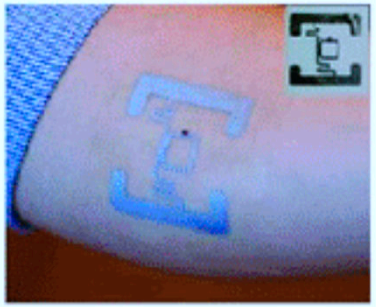


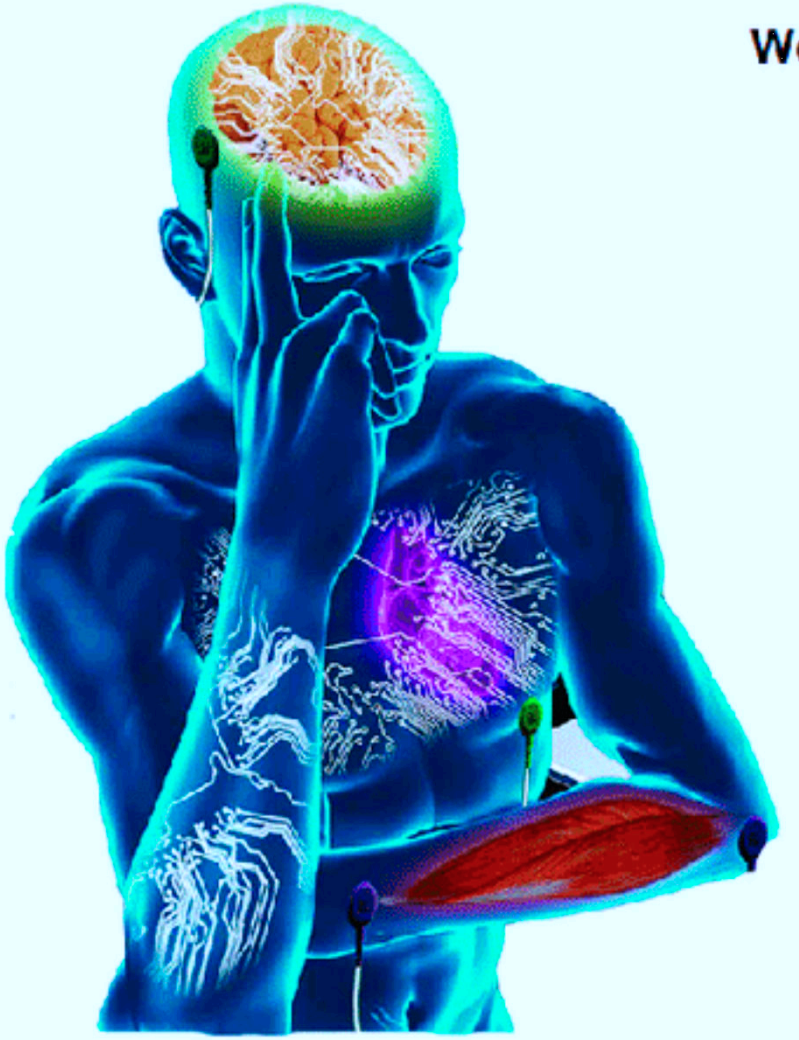




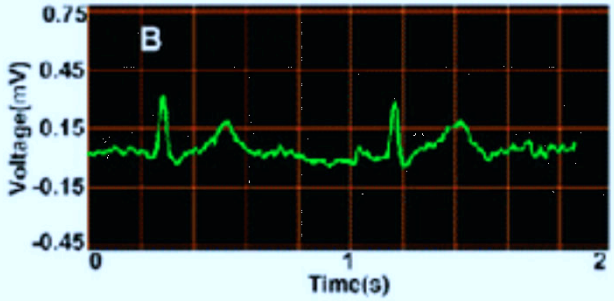
Electrical skin

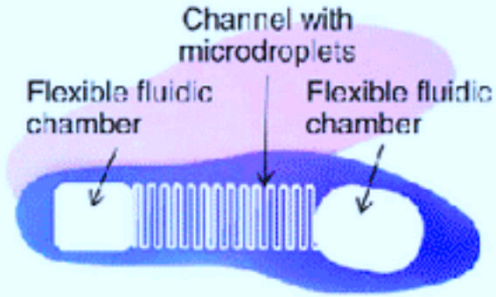


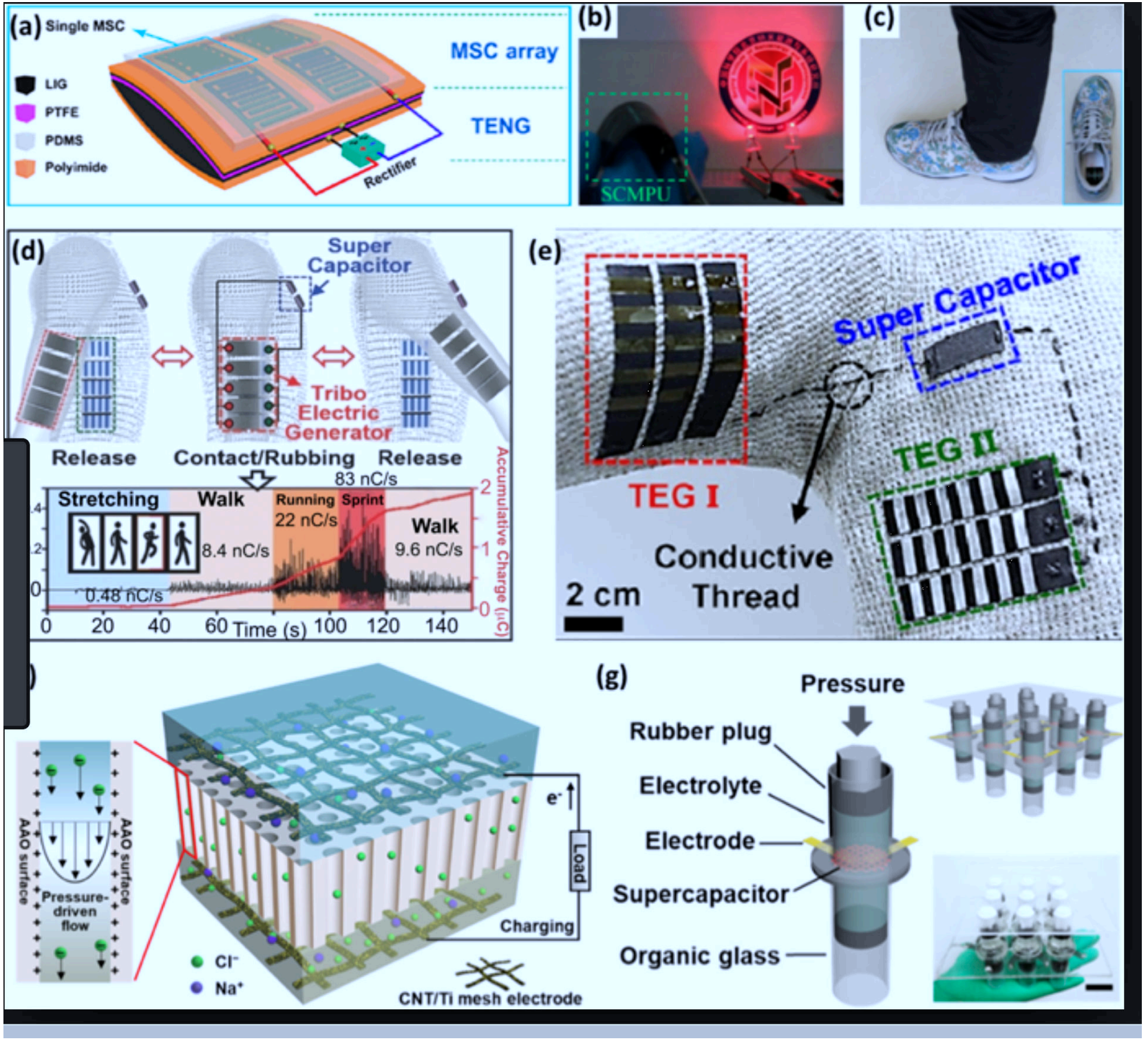


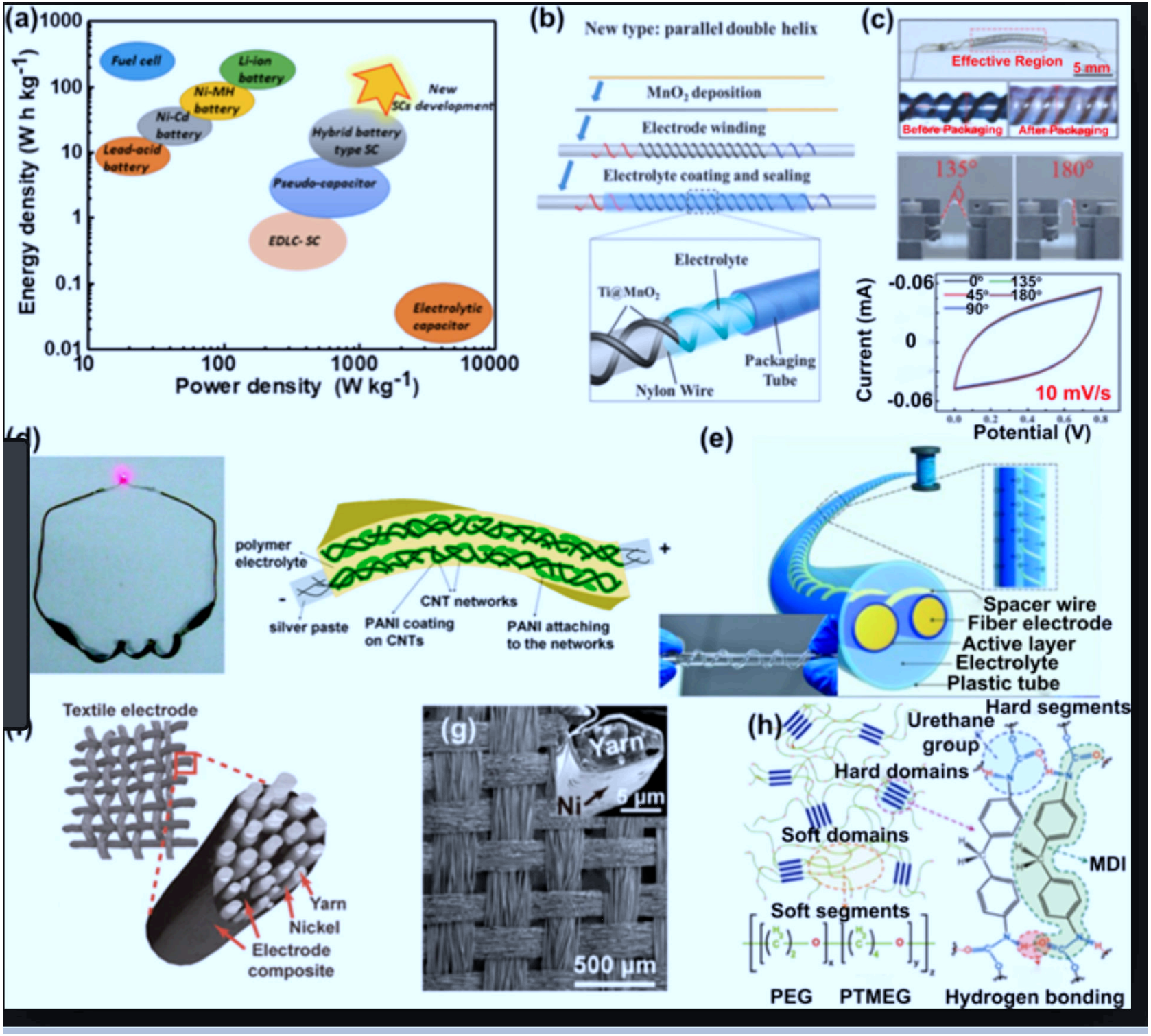


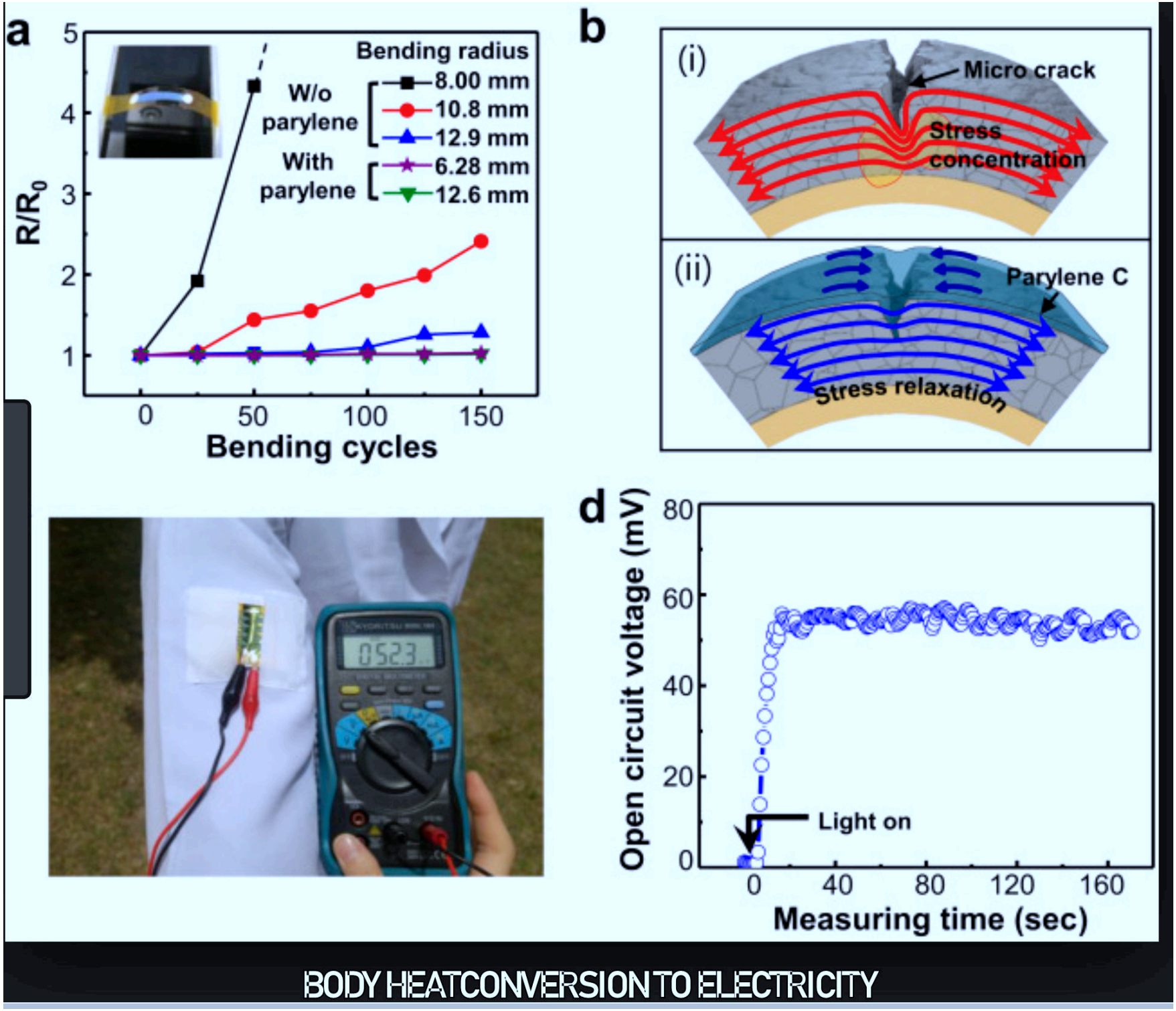
Wearable bioelectronics

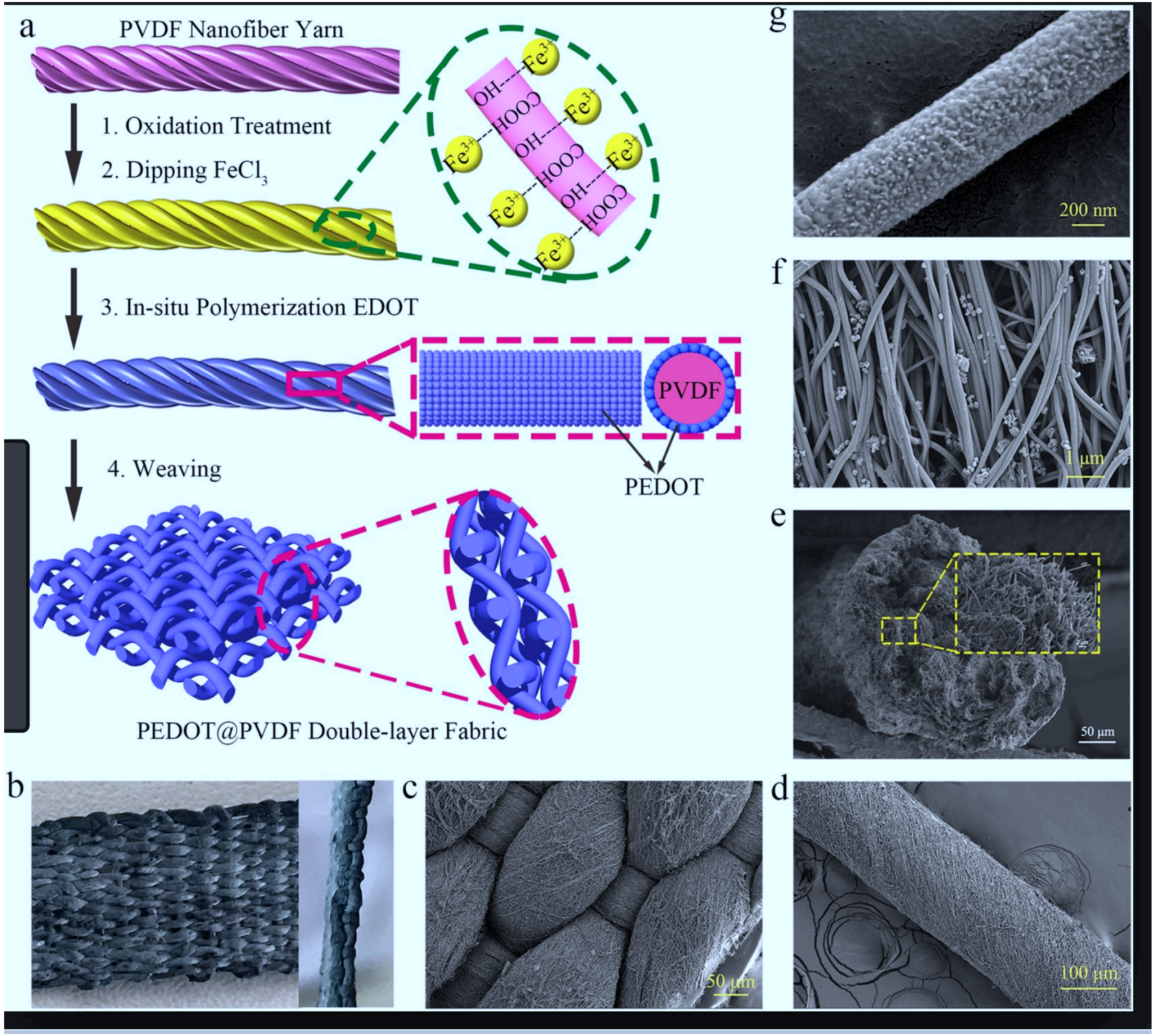


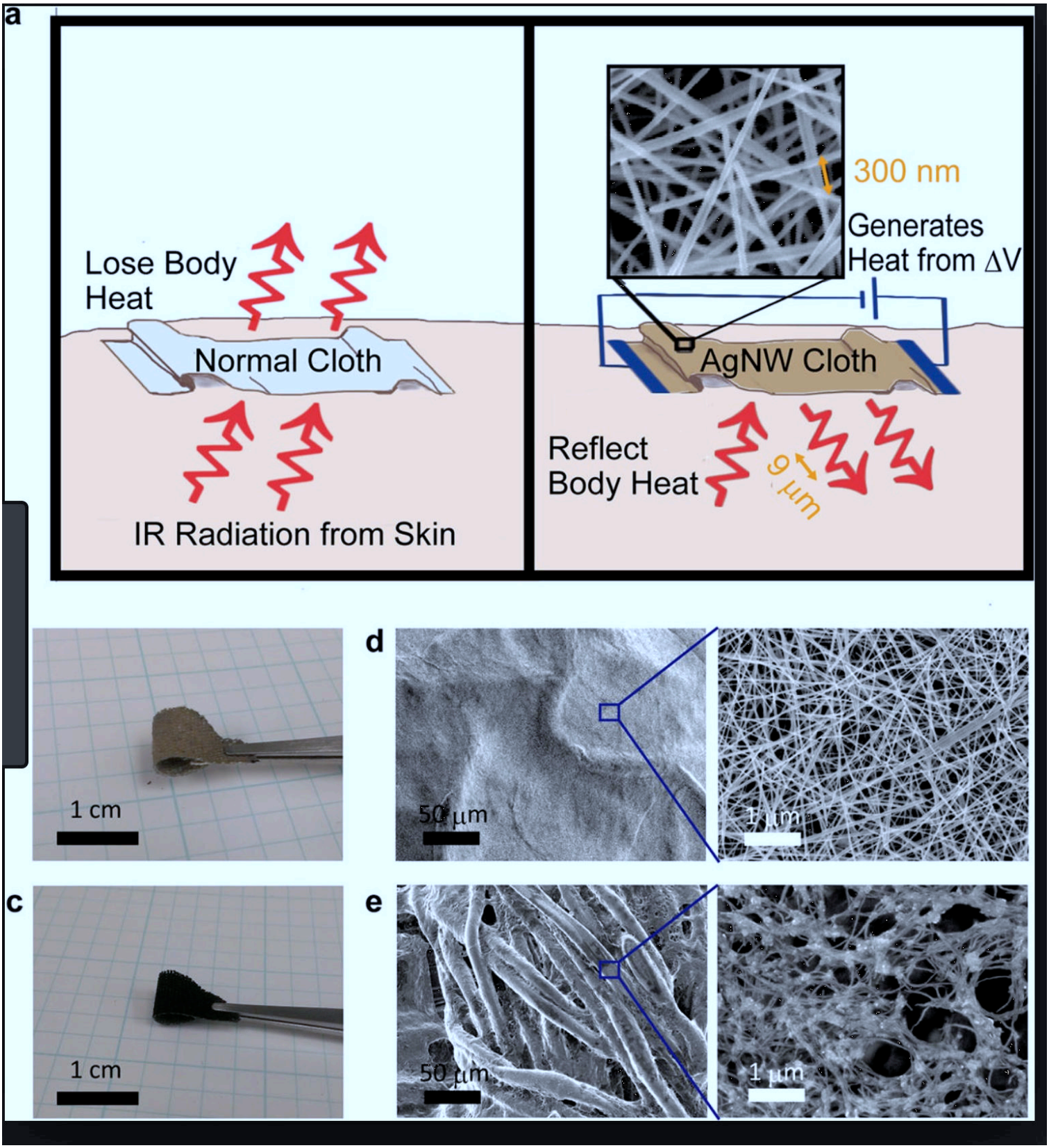


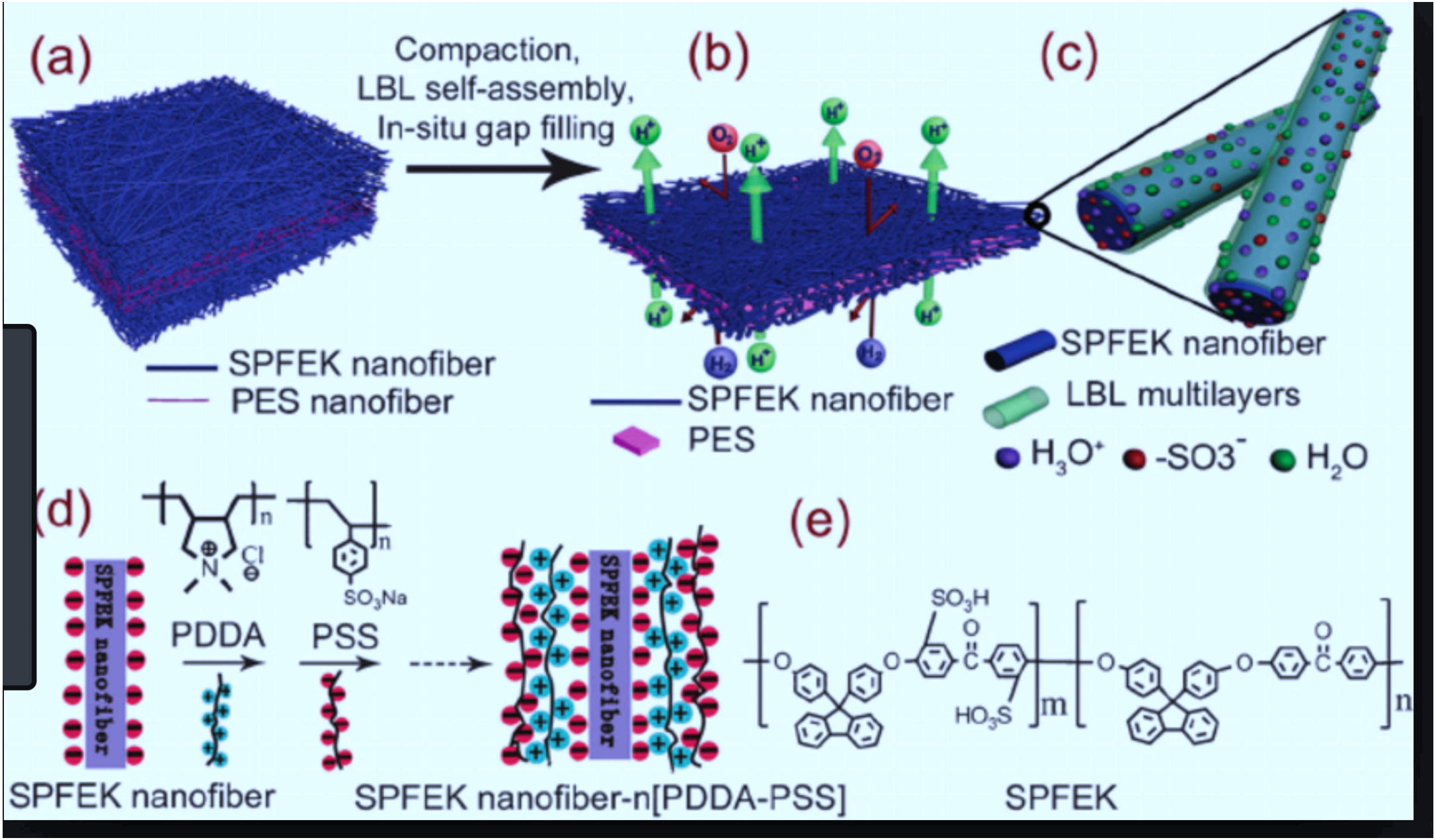

(a)
Single MSC
LIG
PTFE
PDMS
Polyimide
Rectifier
MSC array
TENG
(b)
SCMPU
(c)
(d)
Super Capacitor
Tribo Electric Generator
Release
Contact/Rubbing
Release
Stretching
Walk
Running
Sprint
Walk
83 nC/s
22 nC/s
8.4 nC/s
9.6 nC/s
0.48 nC/s
Time (s)
Accumulative Charge (μC)
(e)
Super Capacitor
TEG II
TEG I
Conductive Thread
2 cm
(g)
Pressure
Rubber plug
Electrolyte
Electrode
Supercapacitor
Organic glass
AAO surface
AAO surface
Pressure-driven flow
Cl⁻
Na⁺
e⁻
Load
Charging
CNT/Ti mesh electrode


(a)
Energy density (W h kg^{-1})
Power density (W kg^{-1})
Fuel cell
Li-ion battery
Ni-MH battery
Ni-Cd battery
Lead-acid battery
New SCs development
Hybrid battery type SC
Pseudo-capacitor
EDLC-SC
Electrolytic capacitor
(b)
New type: parallel double helix
MnO$_2$ deposition
Electrode winding
Electrolyte coating and sealing
Electrolyte
Ti@MnO$_2$
Packaging Tube
Nylon Wire
(c)
Effective Region
5 mm
Before Packaging
After Packaging
135°
180°
Current (mA)
Potential (V)
0°
45°
90°
135°
180°
10 mV/s
(d)
polymer electrolyte
silver paste
PANI coating on CNTs
CNT networks
PANI attaching to the networks
(e)
Spacer wire
Fiber electrode
Active layer
Electrolyte
Plastic tube
(f)
Textile electrode
Yarn
Nickel
Electrode composite
(g)
Yarn
Ni
5 μm
500 μm
(h)
Hard segments
Urethane group
Hard domains
Soft domains
MDI
Soft segments
PEG
PTMEG
Hydrogen bonding

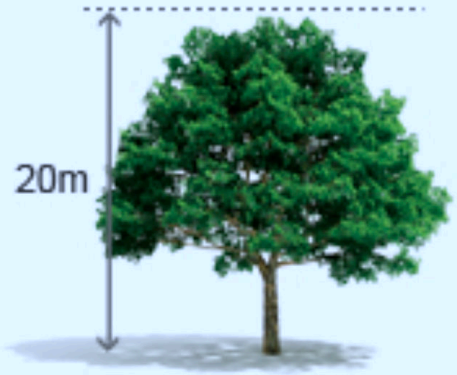

a
5
4
3
2
1
R/R0
0
50
100
150
Bending cycles
Bending radius
W/o parylene
8.00 mm
10.8 mm
12.9 mm
With parylene
6.28 mm
12.6 mm
b
(i)
Micro crack
Stress concentration
(ii)
Parylene C
Stress relaxation
d
Open circuit voltage (mV)
80
60
40
20
0
Light on
0
40
80
120
160
Measuring time (sec)
BODY HEAT CONVERSION TO ELECTRICITY


a
PVDF Nanofiber Yarn
1. Oxidation Treatment
2. Dipping $FeCl_3$
3. In-situ Polymerization EDOT
PVDF
PEDOT
4. Weaving
PEDOT@PVDF Double-layer Fabric
g
200 nm
f
1 μm
e
50 μm
b
c
50 μm
d
100 μm


a
Lose Body Heat
Normal Cloth
IR Radiation from Skin
300 nm
Generates Heat from ΔV
AgNW Cloth
Reflect Body Heat
9 μm
1 cm
d
50 μm
1 μm
c
1 cm
e
50 μm
1 μm


(a)
Compaction,
LBL self-assembly,
In-situ gap filling
(b)
(c)
SPFEK nanofiber
PES nanofiber
SPFEK nanofiber
PES
SPFEK nanofiber
LBL multilayers
H_3O^+
-SO3$^-$
H_2O
(d)
PDDA
PSS
SPFEK nanofiber
SPFEK nanofiber
SPFEK nanofiber-n[PDDA-PSS]
(e)
SPFEK

Wood



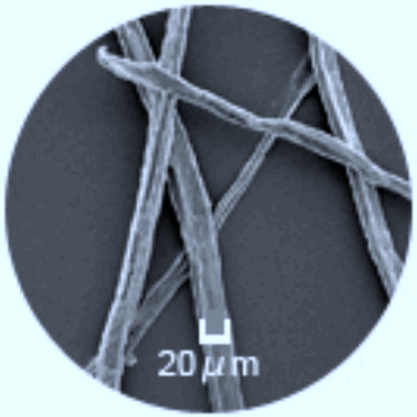
1/1000
Logging and chipping

Wood chips

1/1000
Pulping Obtaining wood fibers

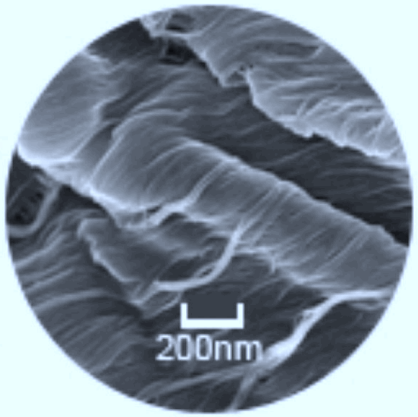
Wood fibers(pulp)

1/1000
Nanofibrillation (miniaturization) Fibrillation of a bundle of wood fibers



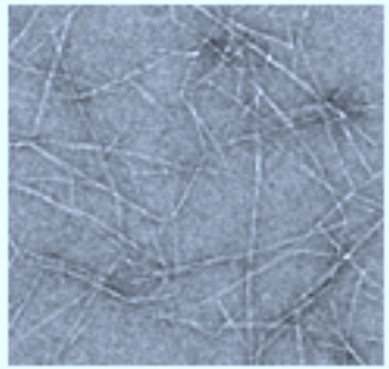
A wood fiber is approximately 20μm wide.

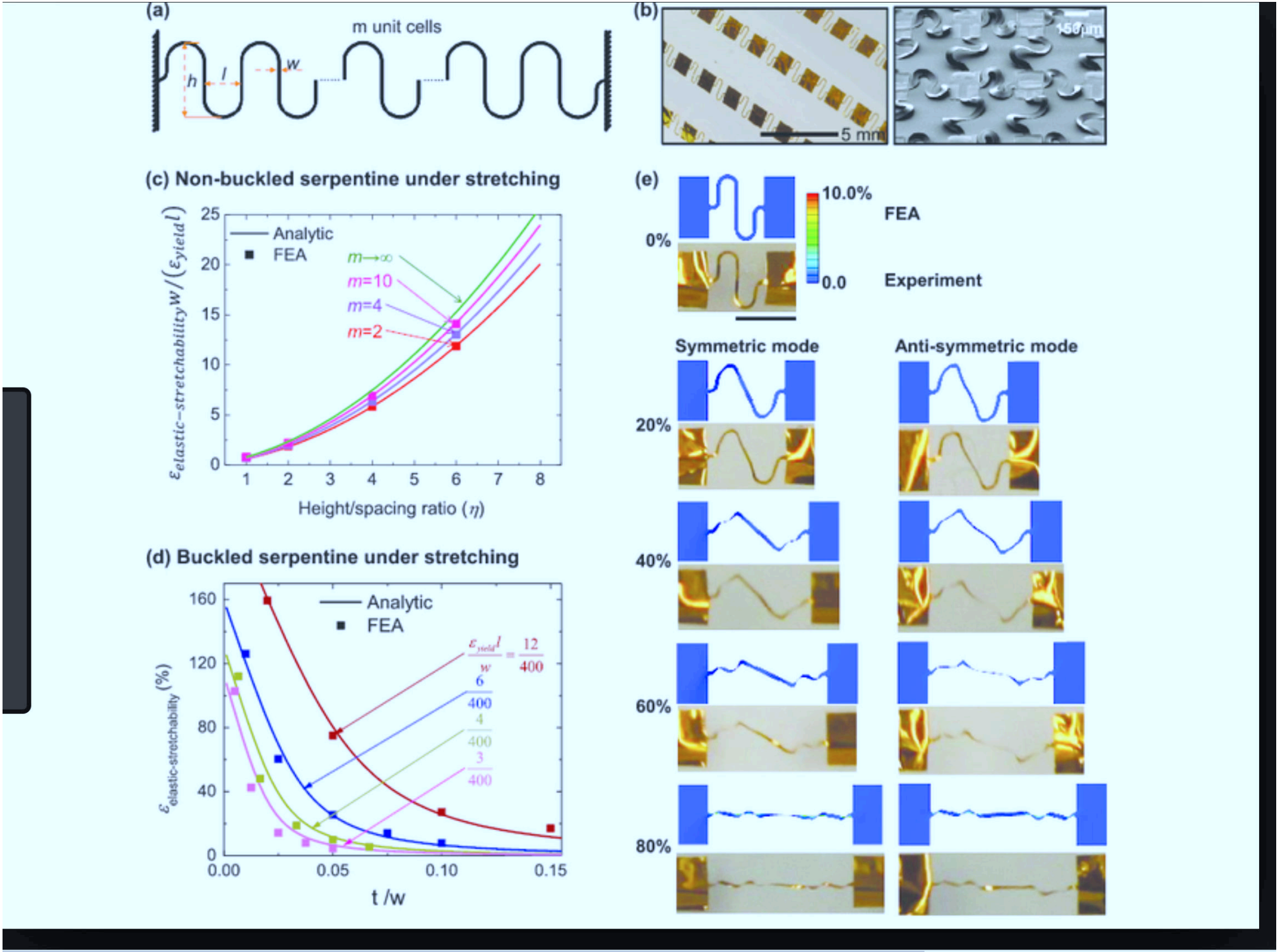
Magnify the image of the surface of wood fiber

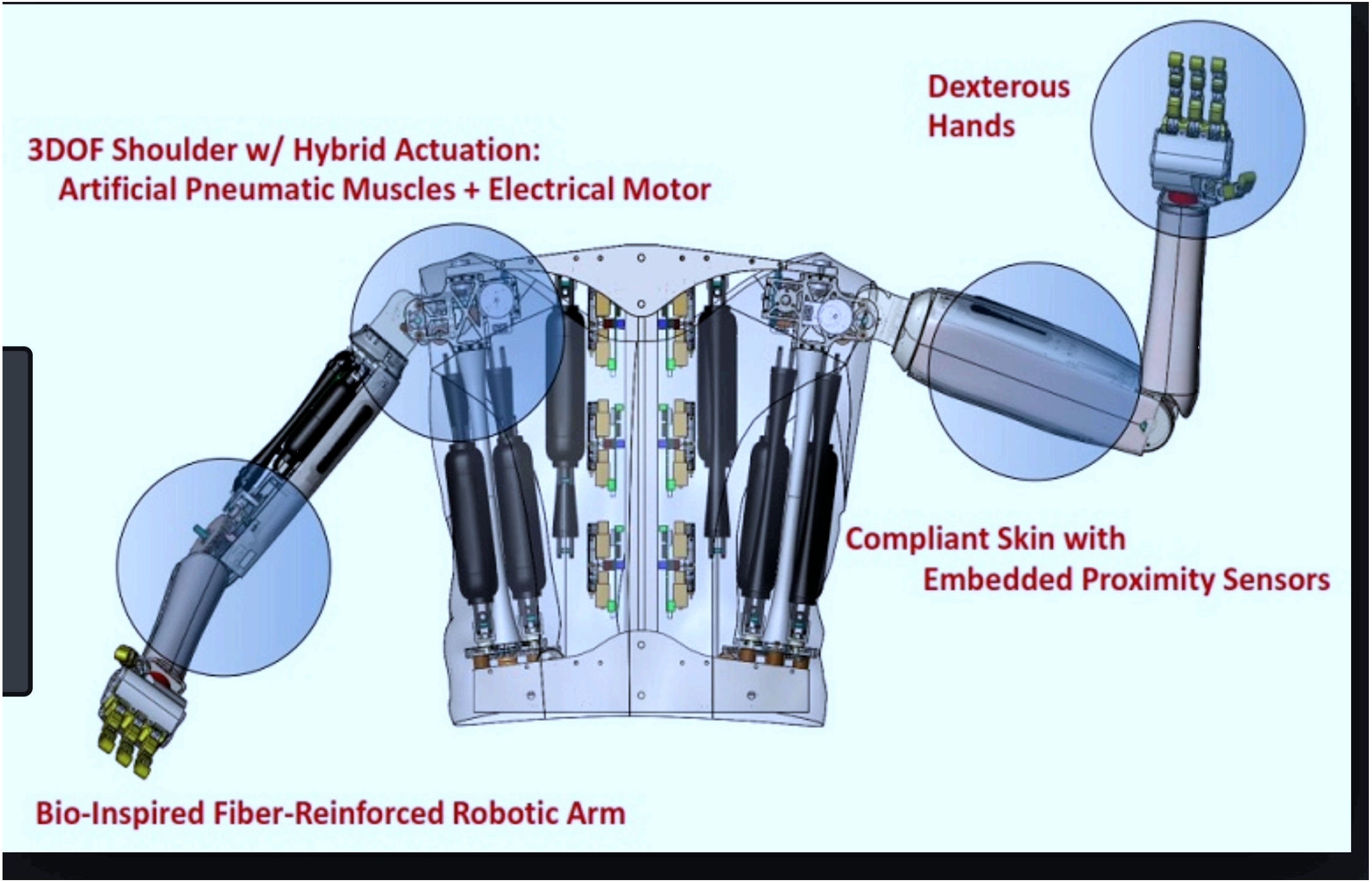


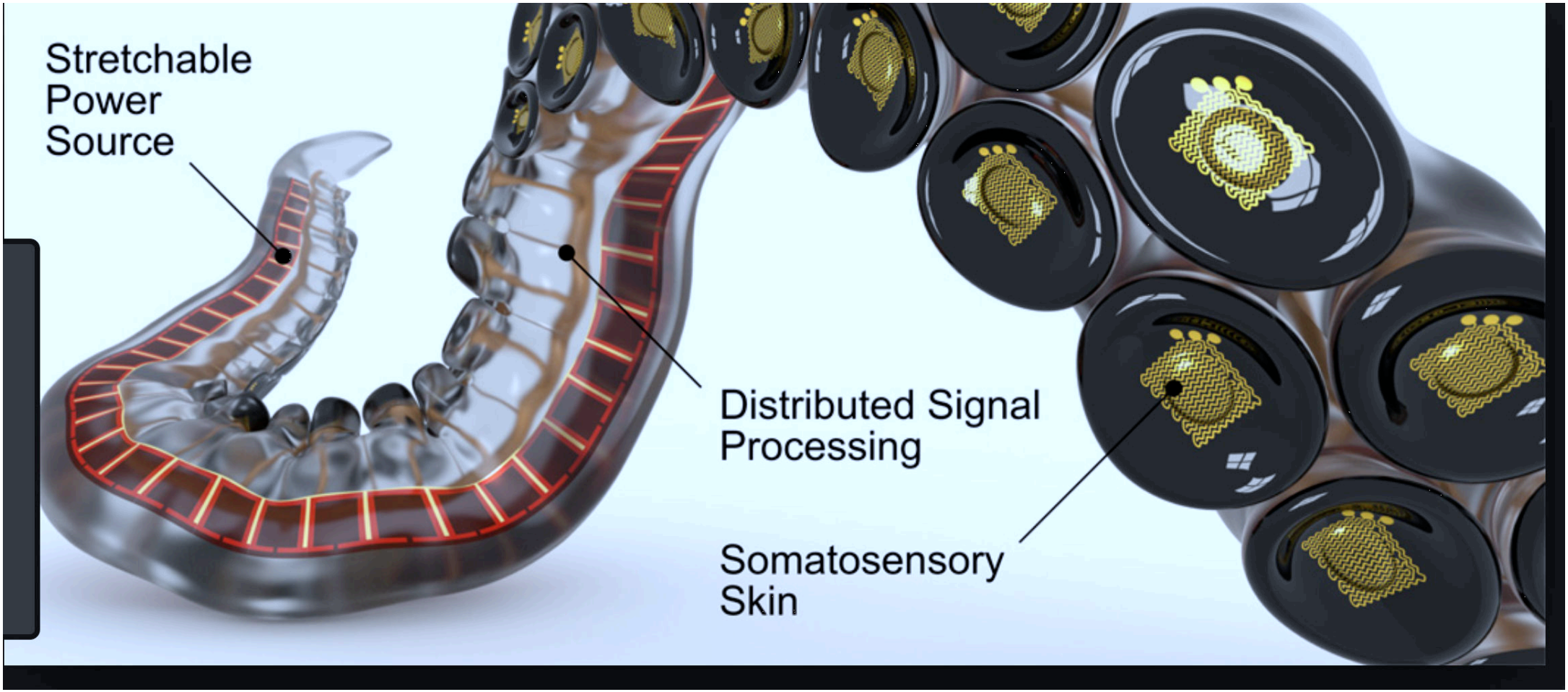
Magnify the surface of a wood fiber and you wil find that it consists of a bundle of countless nanofibers

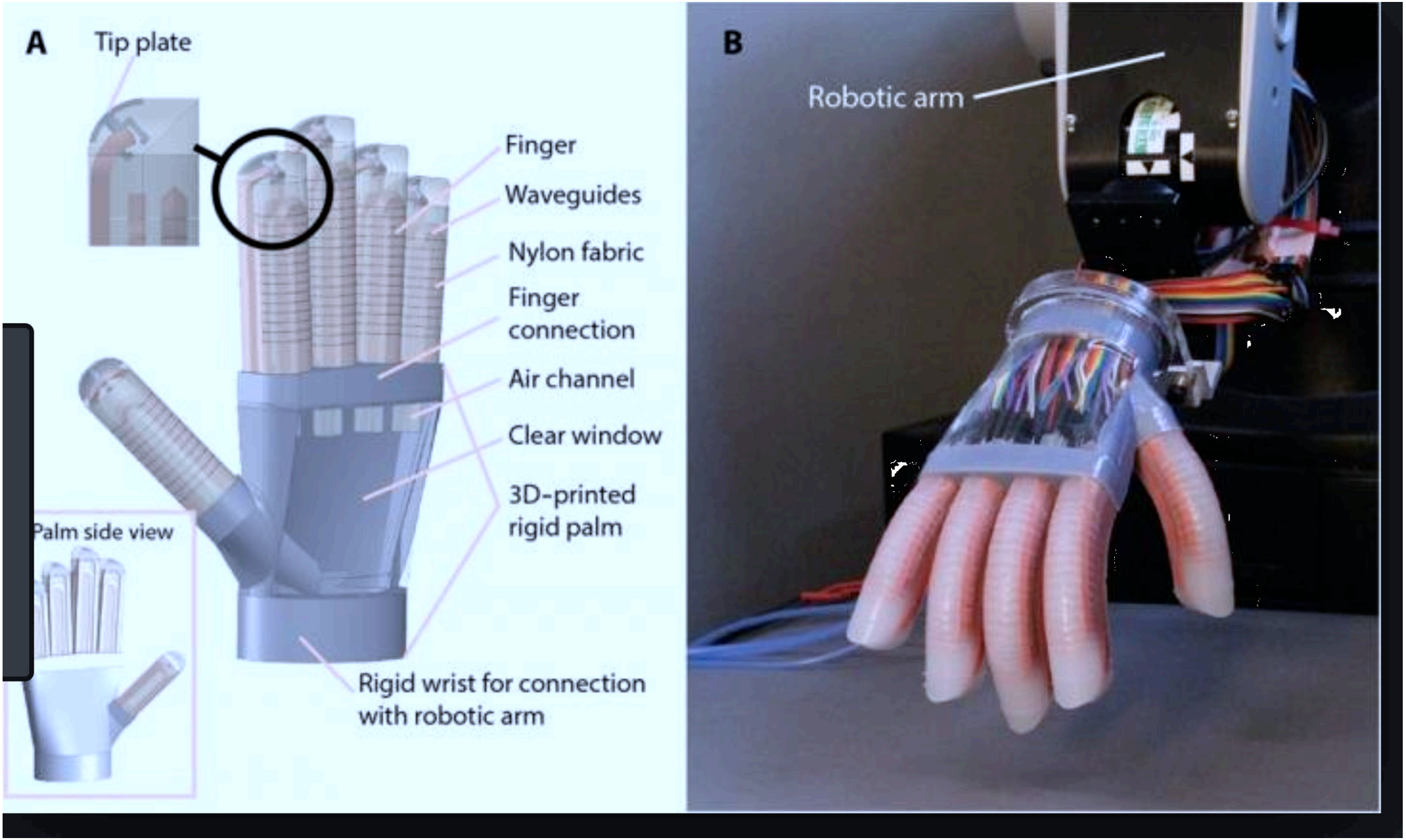
Cellulose nanofibers

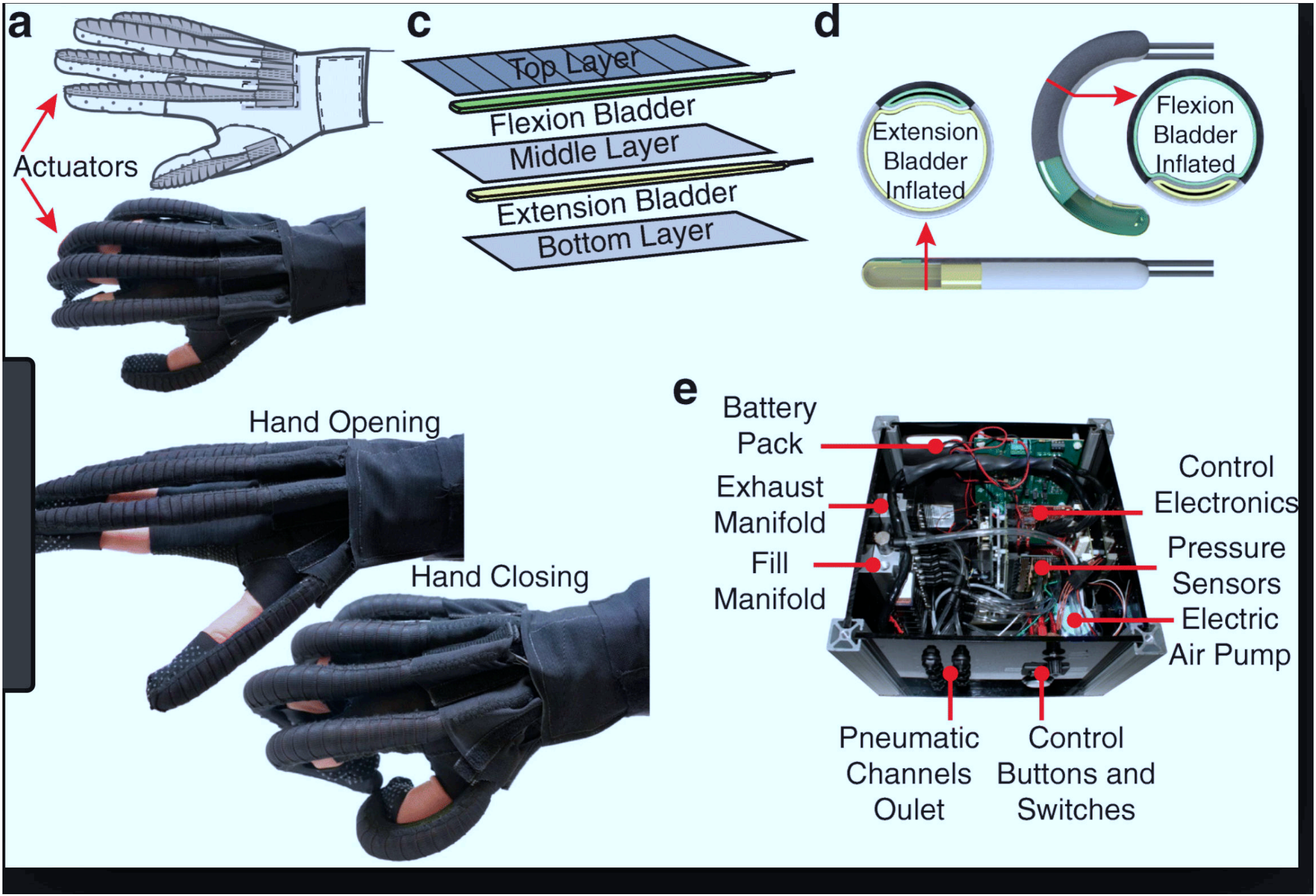



(a)
m unit cells
h
l
w
(b)
5 mm
150 μm
(c) Non-buckled serpentine under stretching
Analytic
FEA
m→∞
m=10
m=4
m=2
Height/spacing ratio (η)
(d) Buckled serpentine under stretching
Analytic
FEA
t /w
(e)
10.0%
0.0
FEA
Experiment
0%
Symmetric mode
Anti-symmetric mode
20%
40%
60%
80%


Dexterous
Hands
3DOF Shoulder w/ Hybrid Actuation:
Artificial Pneumatic Muscles + Electrical Motor
Compliant Skin with
Embedded Proximity Sensors
Bio-Inspired Fiber-Reinforced Robotic Arm

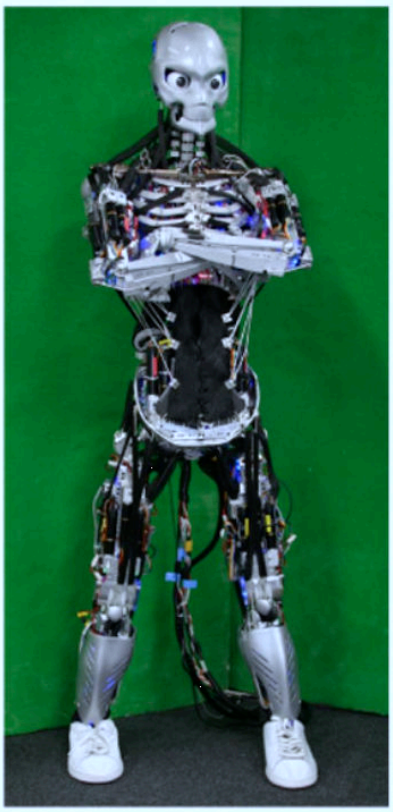

Stretchable
Power
Source
Distributed Signal
Processing
Somatosensory
Skin


A
Tip plate
Finger
Waveguides
Nylon fabric
Finger connection
Air channel
Clear window
3D-printed rigid palm
Palm side view
Rigid wrist for connection with robotic arm
B
Robotic arm


a
Actuators
c
Top Layer
Flexion Bladder
Middle Layer
Extension Bladder
Bottom Layer
d
Extension Bladder Inflated
Flexion Bladder Inflated
Hand Opening
Hand Closing
e
Battery Pack
Exhaust Manifold
Fill Manifold
Control Electronics
Pressure Sensors
Electric Air Pump
Pneumatic Channels Oulet
Control Buttons and Switches

Human mimetic humanoid "Kenshiro" (2012-)

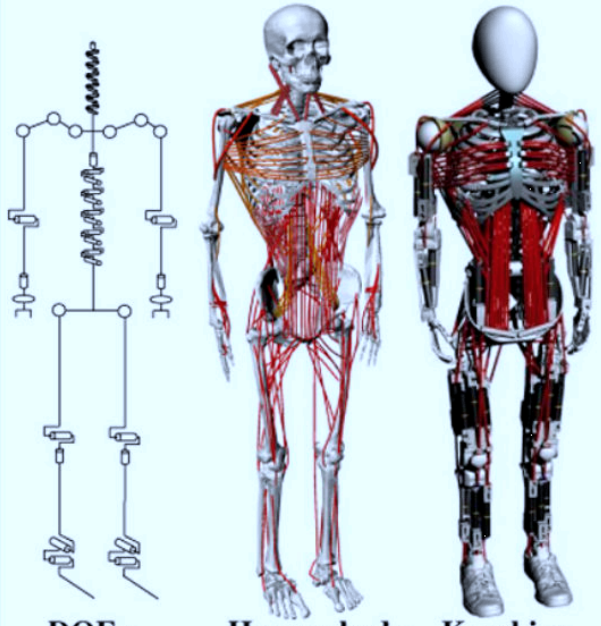
Specification
Height: 160 [cm]
Weight: 51.9 [kg]
DOFs: 64
Muscle actuators: 87



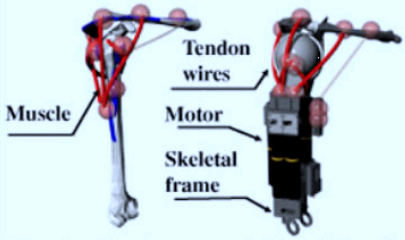
Flexible multiple spine

- Human-like S-curve structure
- Different spring unit for each vertebra

Musculoskeletal structure based on anatomy

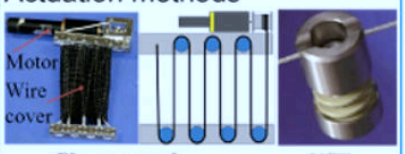


Adhesion of muscles and bones

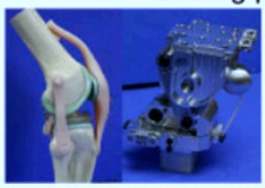


- Muscle adhesion prevents joint dislocation

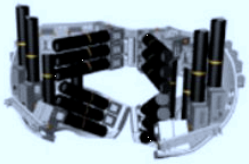
Actuation methods



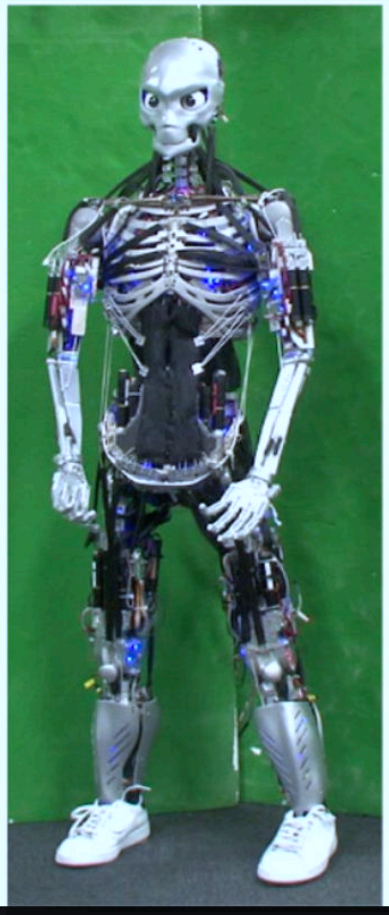
Human mimetic leg part

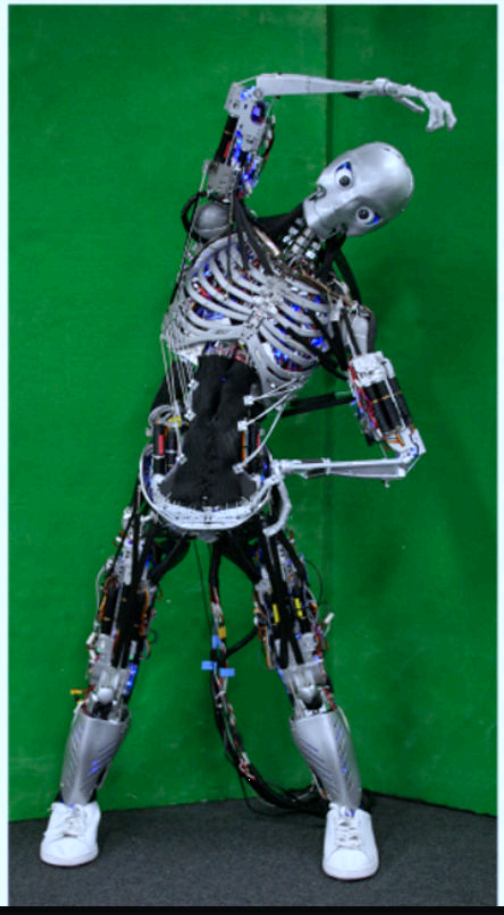


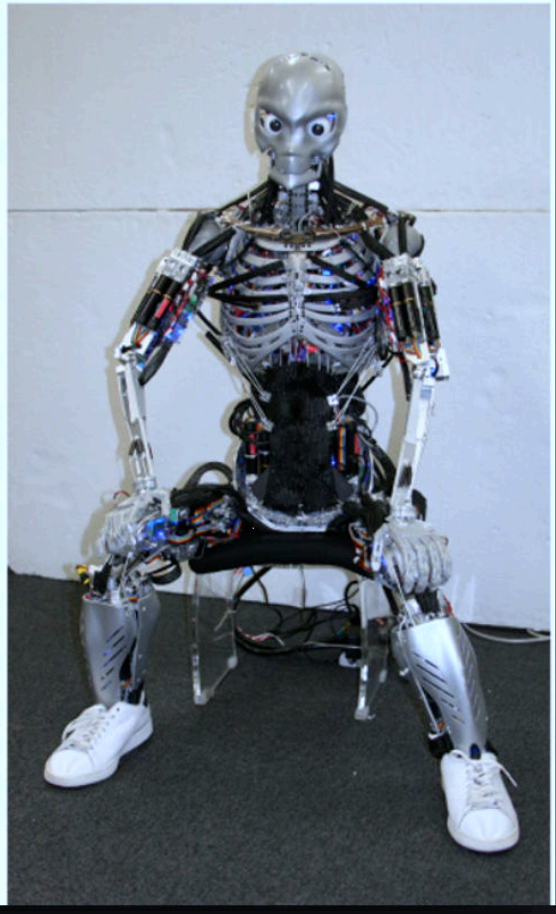
- Knee with screw-home mechanism enabling yaw rotation



- Free formed pelvis with numerous muscle units



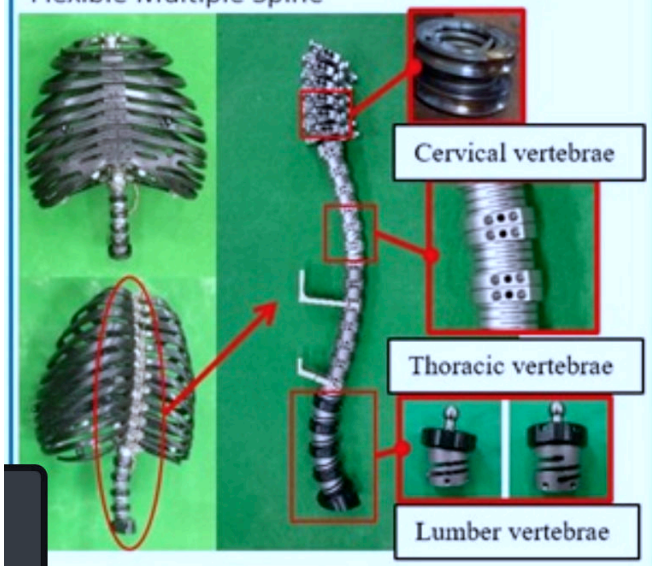




Musculoskeletal Humanoid "Kengoro" (2016-)

JSK

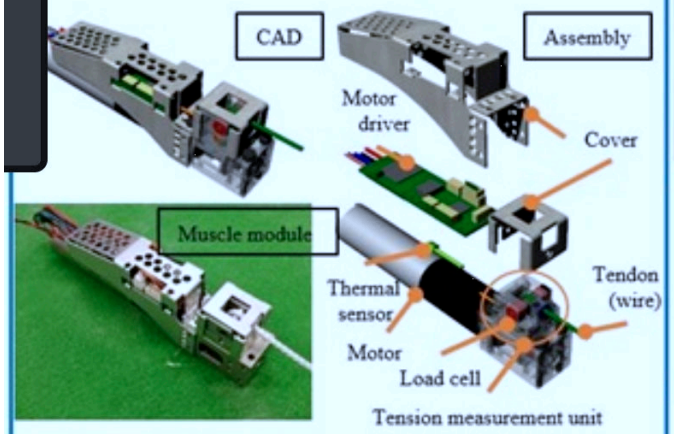
Flexible Multiple Spine



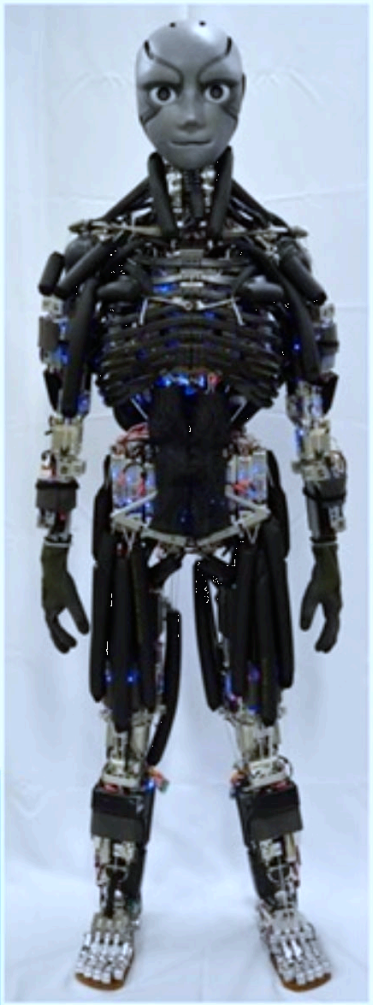
Human-like S-curve structure

Different spring unit for each vertebrae

ensor-driver integrated muscle module

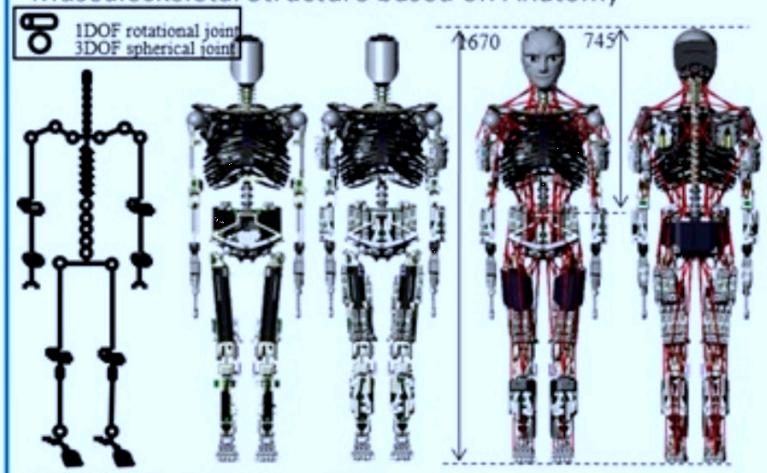


- Flexible muscle control by tension

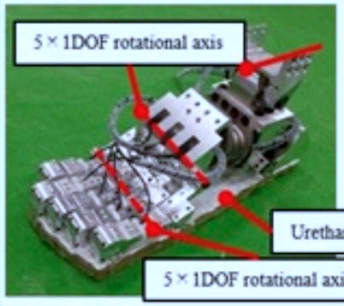


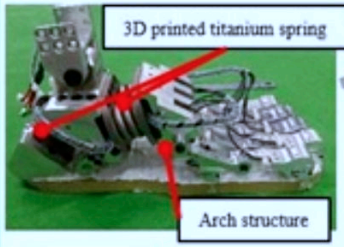
Height: 167[cm]
Weight: 56[kg]
DOFs: 114
Actuator: 106 Motors
(Under Development)

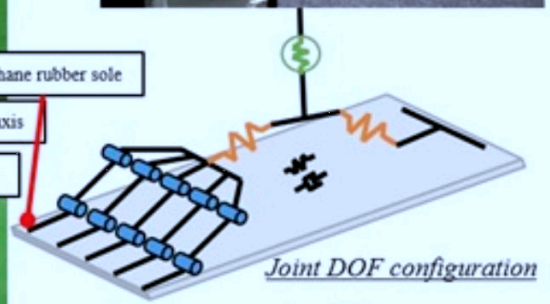
Musculoskeletal Structure based on Anatomy



Human mimetic foot structure

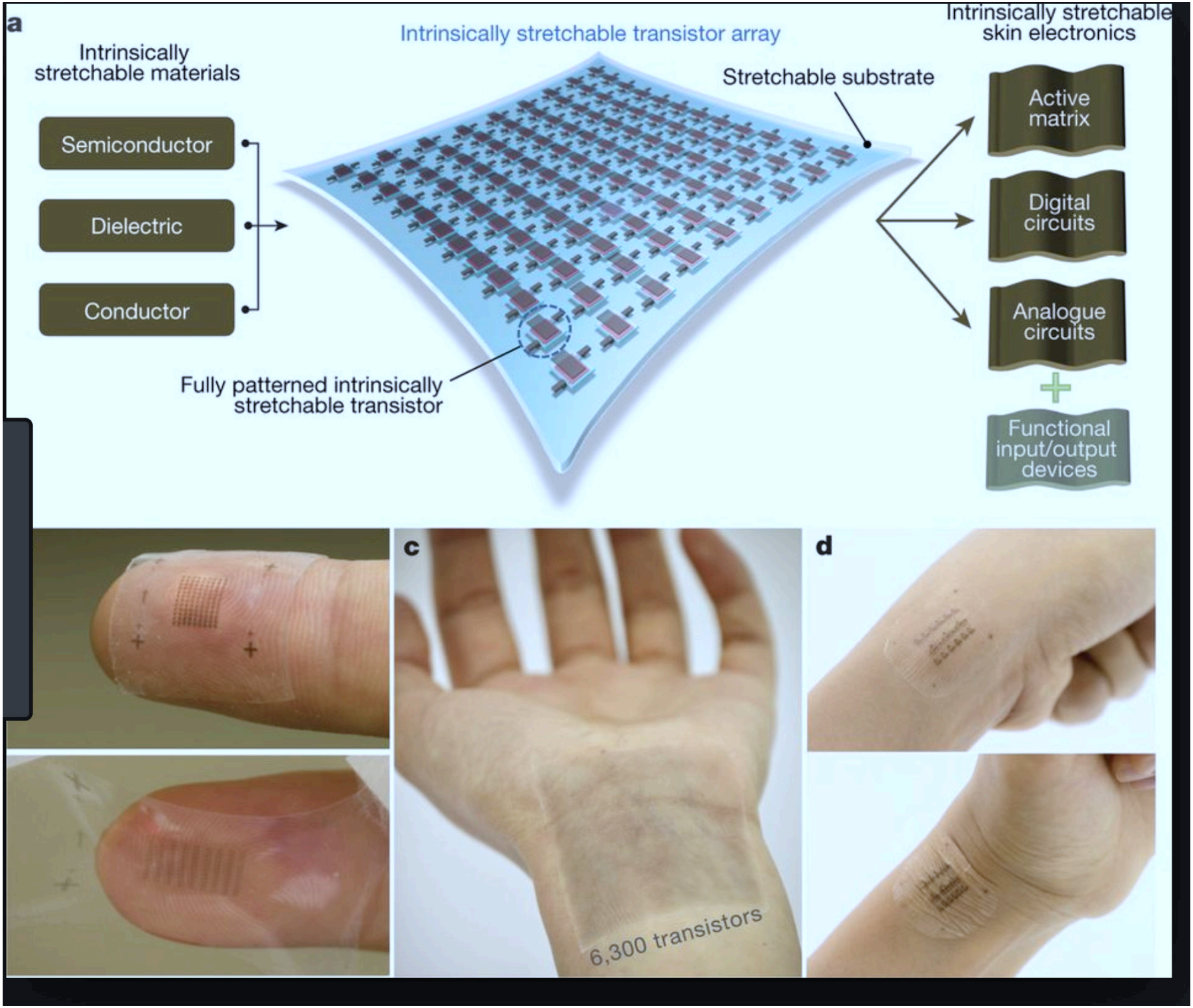


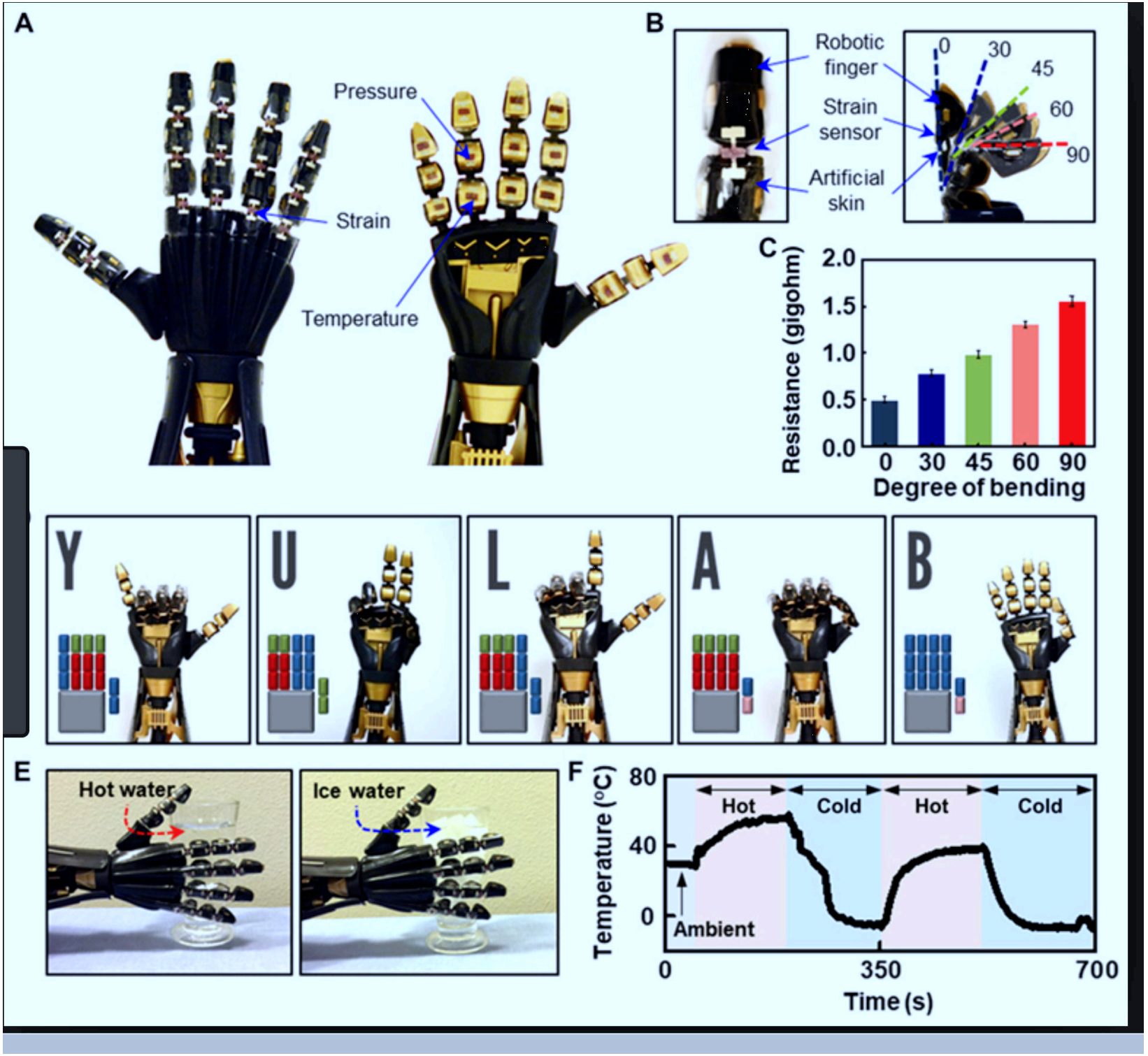


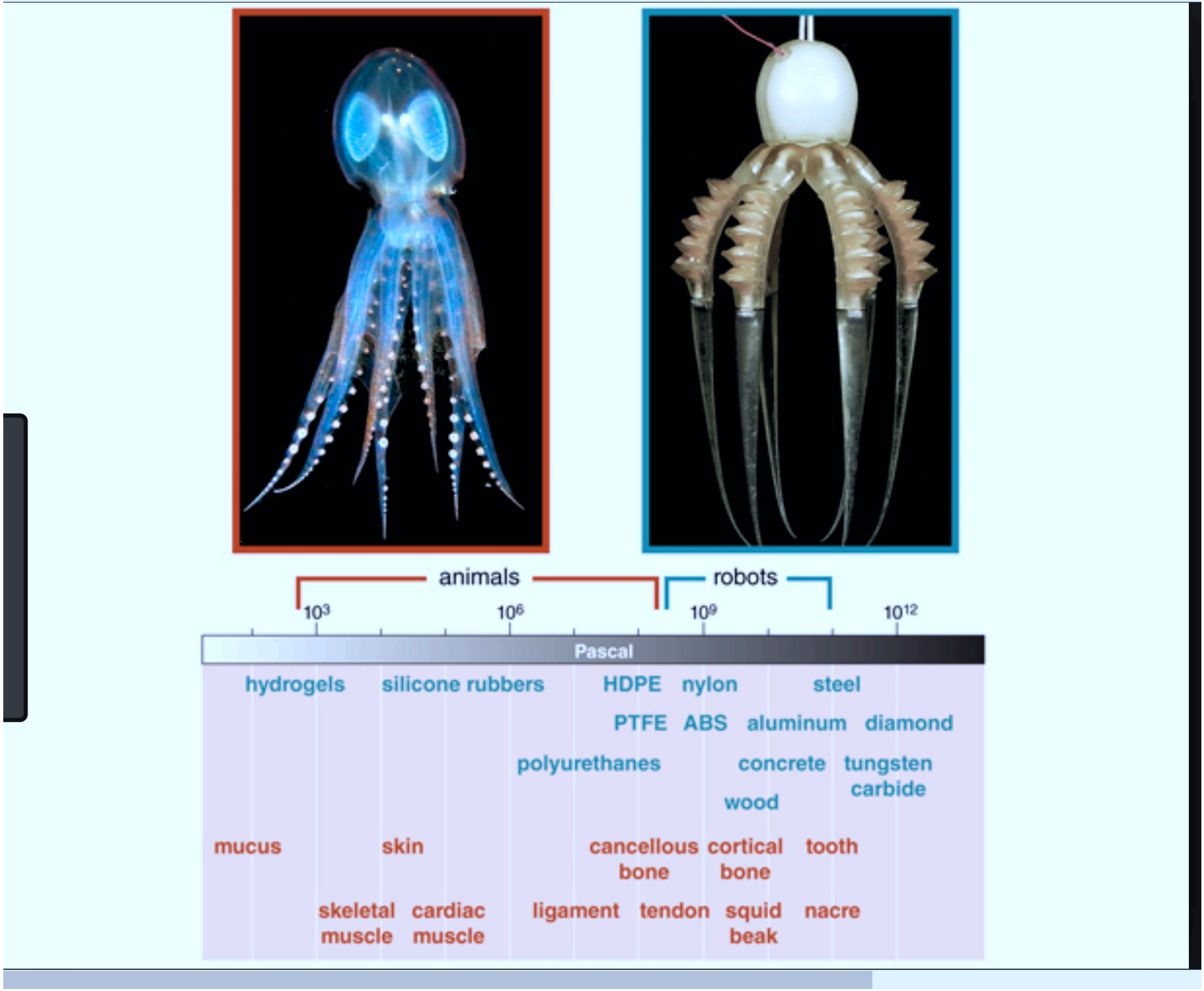


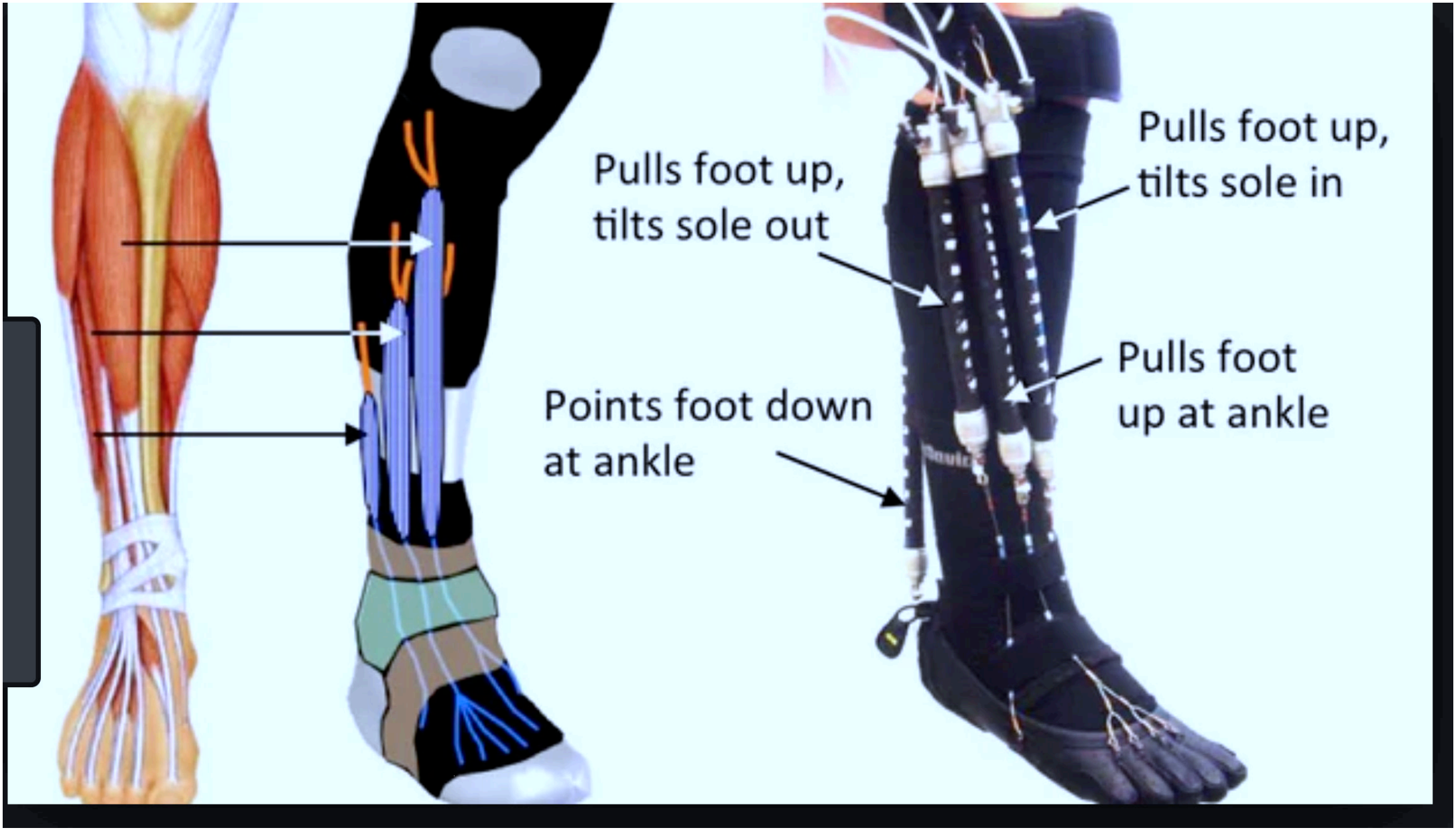
: 1DOF rotational joint
: 3DOF spring joint
: 3DOF spherical joint with elastic constraint

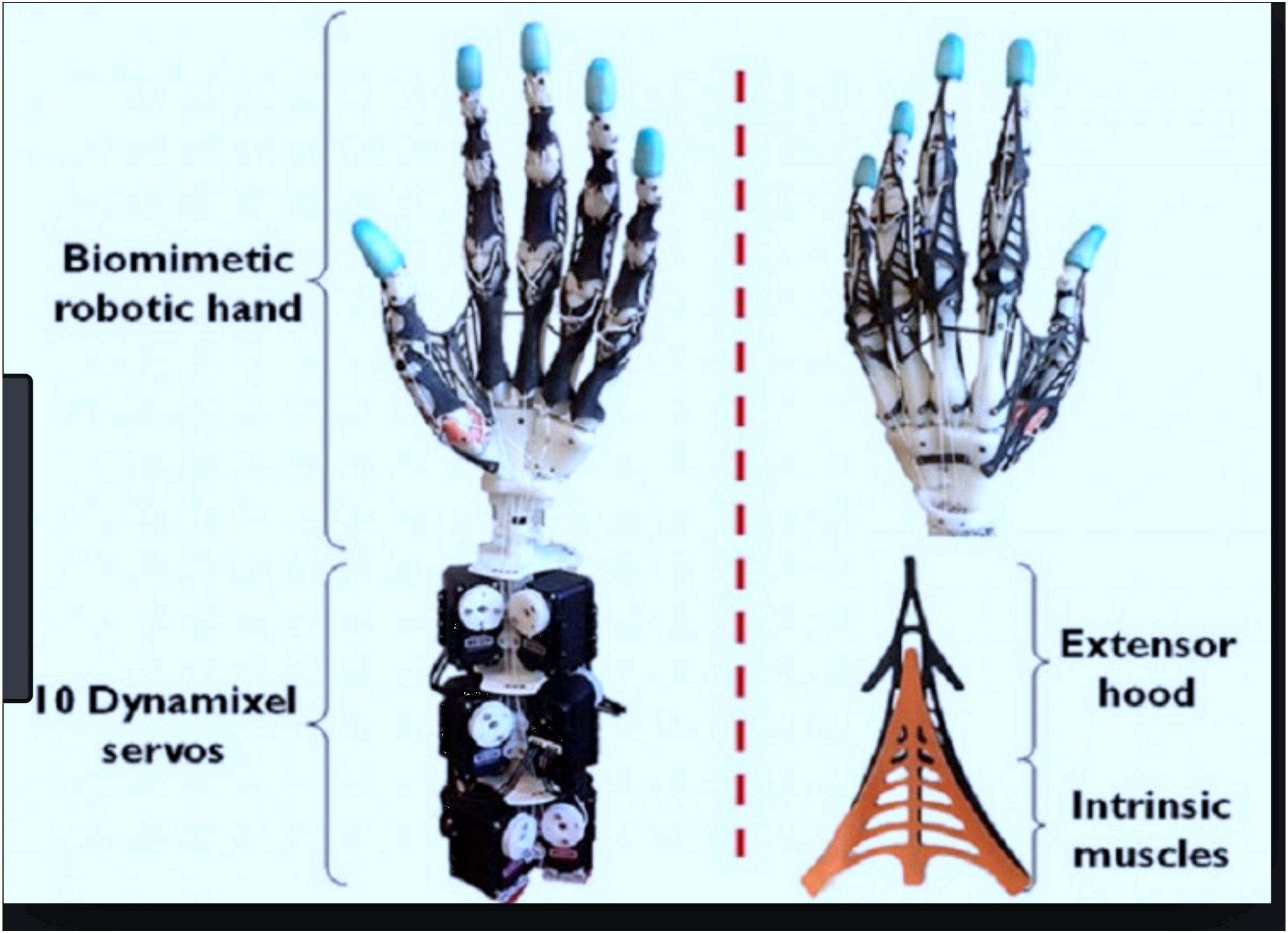
Total DOFs: 19
- Ankle : 3
- Foot : 16

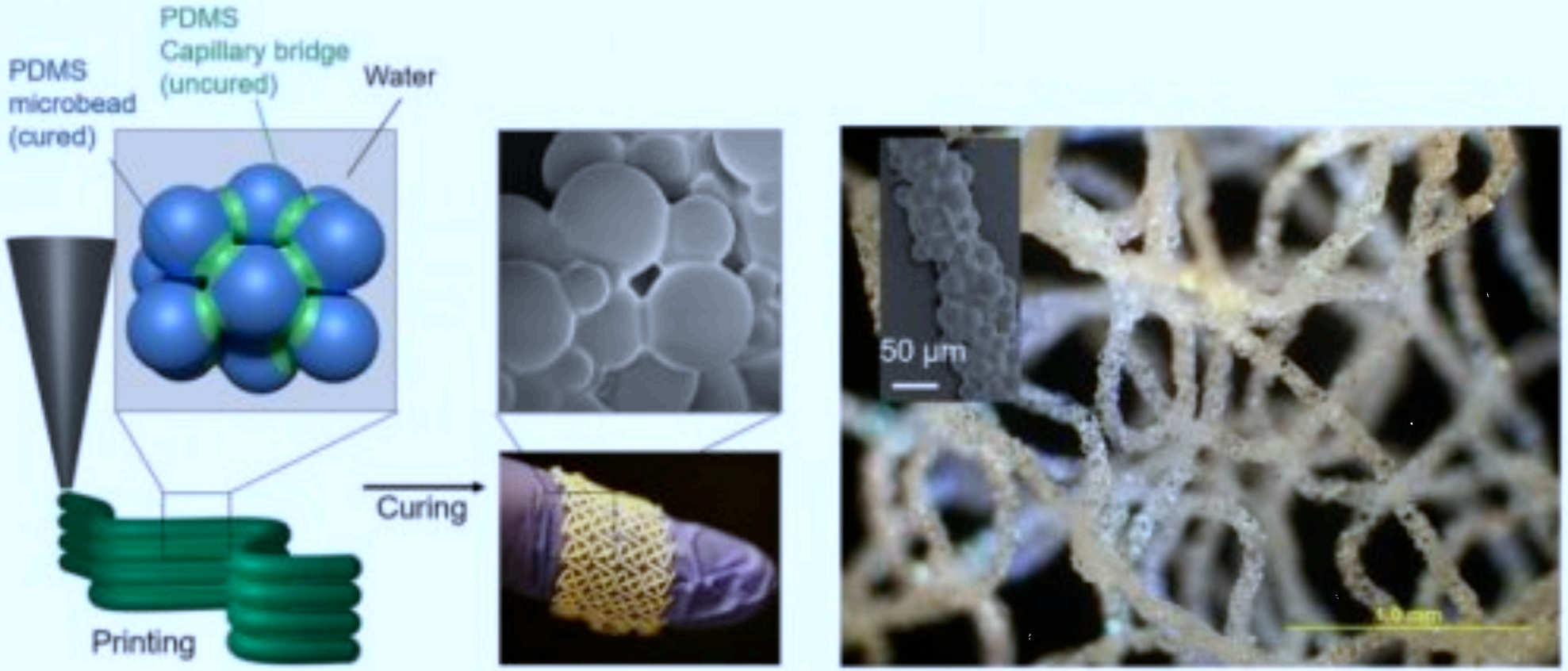

a
Intrinsically stretchable transistor array
Intrinsically stretchable skin electronics
Intrinsically stretchable materials
Semiconductor
Dielectric
Conductor
Stretchable substrate
Fully patterned intrinsically stretchable transistor
Active matrix
Digital circuits
Analogue circuits
Functional input/output devices
c
6,300 transistors
d


A
Pressure
Strain
Temperature
B
Robotic finger
Strain sensor
Artificial skin
0
30
45
60
90
C
Resistance (gigohm)
2.0
1.5
1.0
0.5
0.0
0 30 45 60 90
Degree of bending
Y
U
L
A
B
E
Hot water
Ice water
F
Temperature (°C)
80
40
0
Hot
Cold
Hot
Cold
Ambient
0
350
700
Time (s)


animals
robots
10^3
10^6
10^9
10^{12}
Pascal
hydrogels
silicone rubbers
HDPE
nylon
steel
PTFE
ABS
aluminum
diamond
polyurethanes
concrete
tungsten carbide
wood
mucus
skin
cancellous bone
cortical bone
tooth
skeletal muscle
cardiac muscle
ligament
tendon
squid beak
nacre


Pulls foot up, tilts sole out
Points foot down at ankle
Pulls foot up, tilts sole in
Pulls foot up at ankle


Biomimetic robotic hand
10 Dynamixel servos
Extensor hood
Intrinsic muscles


PDMS
Capillary bridge
(uncured)
PDMS
microbead
(cured)
Water
Curing
Printing
50 µm